

# Presenting Probabilistic Forecast Information for Decision Support Applications

VLab Forum – September 2020

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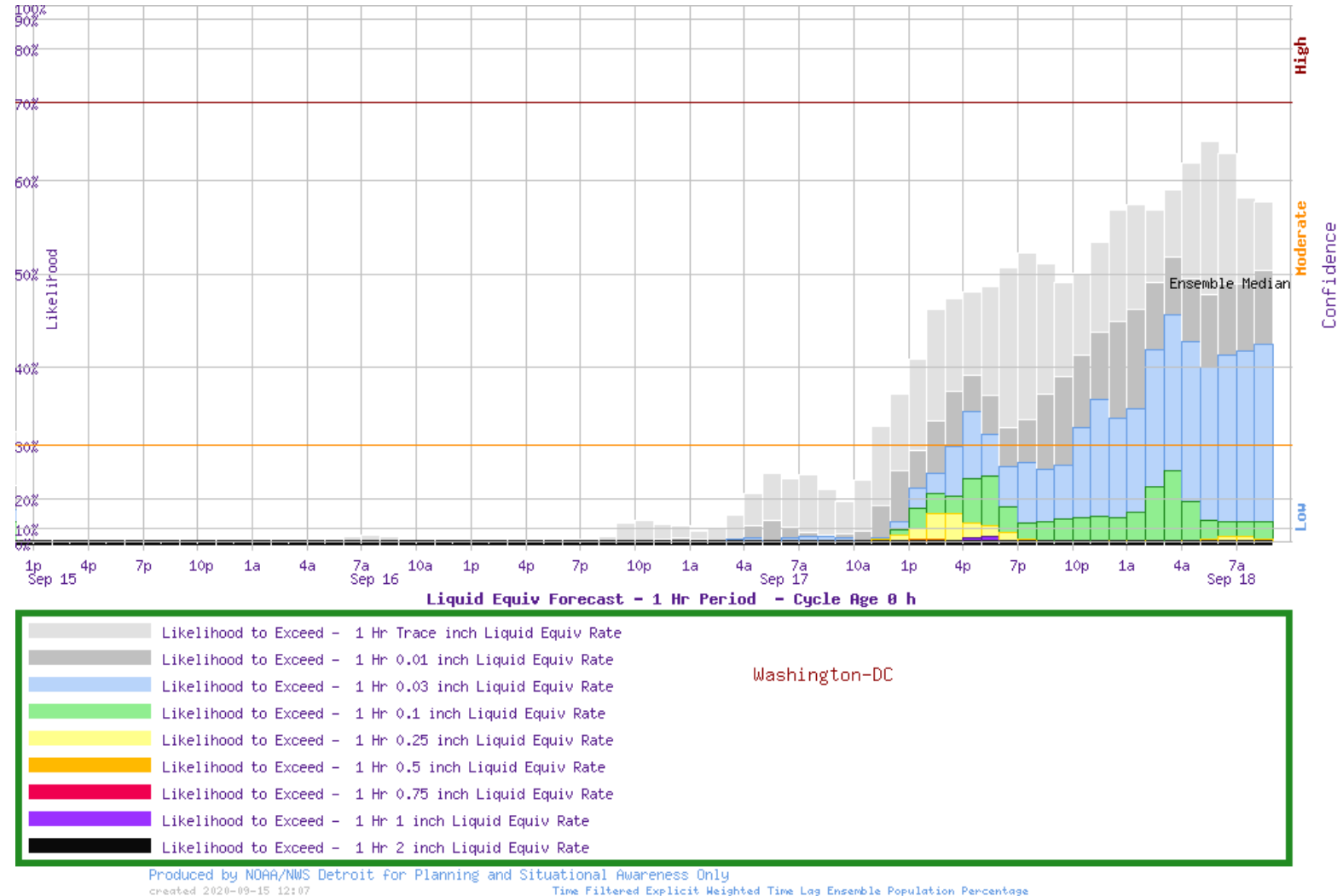
Science and Operations Officer – WFO Detroit

# WFO Detroit – DSS portfolio

- Premise: timeseries layered threshold probability presentation
  - Condenses information for ease of use and direct application to forecaster and client needs
- Primary clients
  - Transportation Sector
    - Wayne County Airport Authority (WCAA) – Detroit Metro Airport (DTW)
    - Michigan Department of Transportation (MDOT)
      - Supporting county/municipal road departments
    - Cleveland Center Weather Service Unit (CWSU ZOB) – FAA Detroit TRACON (D21)
  - Homeland Security
    - U.S. Coast Guard – Sector Detroit
    - City of Detroit DHS
  - Water Management
    - Detroit Water and Sewage
    - Michigan Department of Environment Great Lakes and Energy (EGLE) – local district

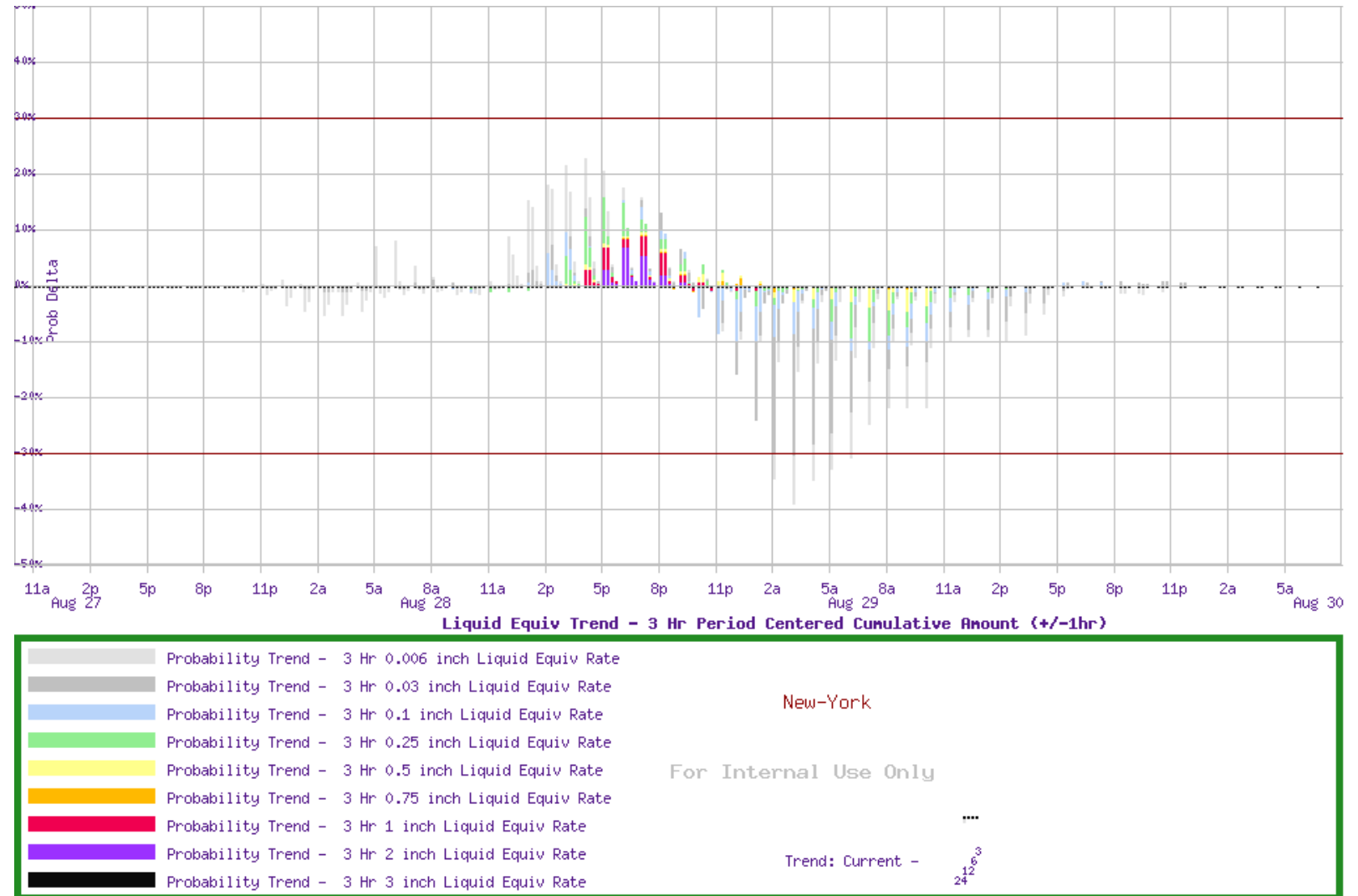
# Layered Probability Timelines

- Uses all available BUFR data – decaying time lagged to bolster ensemble population sample size
  - SREF, HREF, GFS, NAM, RAP, HRRR
- Time Filter is applied
  - 3h centered moving average
- Hourly Based and Hourly Cadence
- Precipitation variables also have accumulating centered moving windows (3, 6, and 12 hours)
- QPF, Snow, Ice, Sleet, Snow Ratio (character), precipitation type, Wind / Gust, Direction Change, Apparent Temp, WBGT, Freezing Temp, Extreme Temp, CAPE, Ceilings, plus other applications and diagnostics are being tested



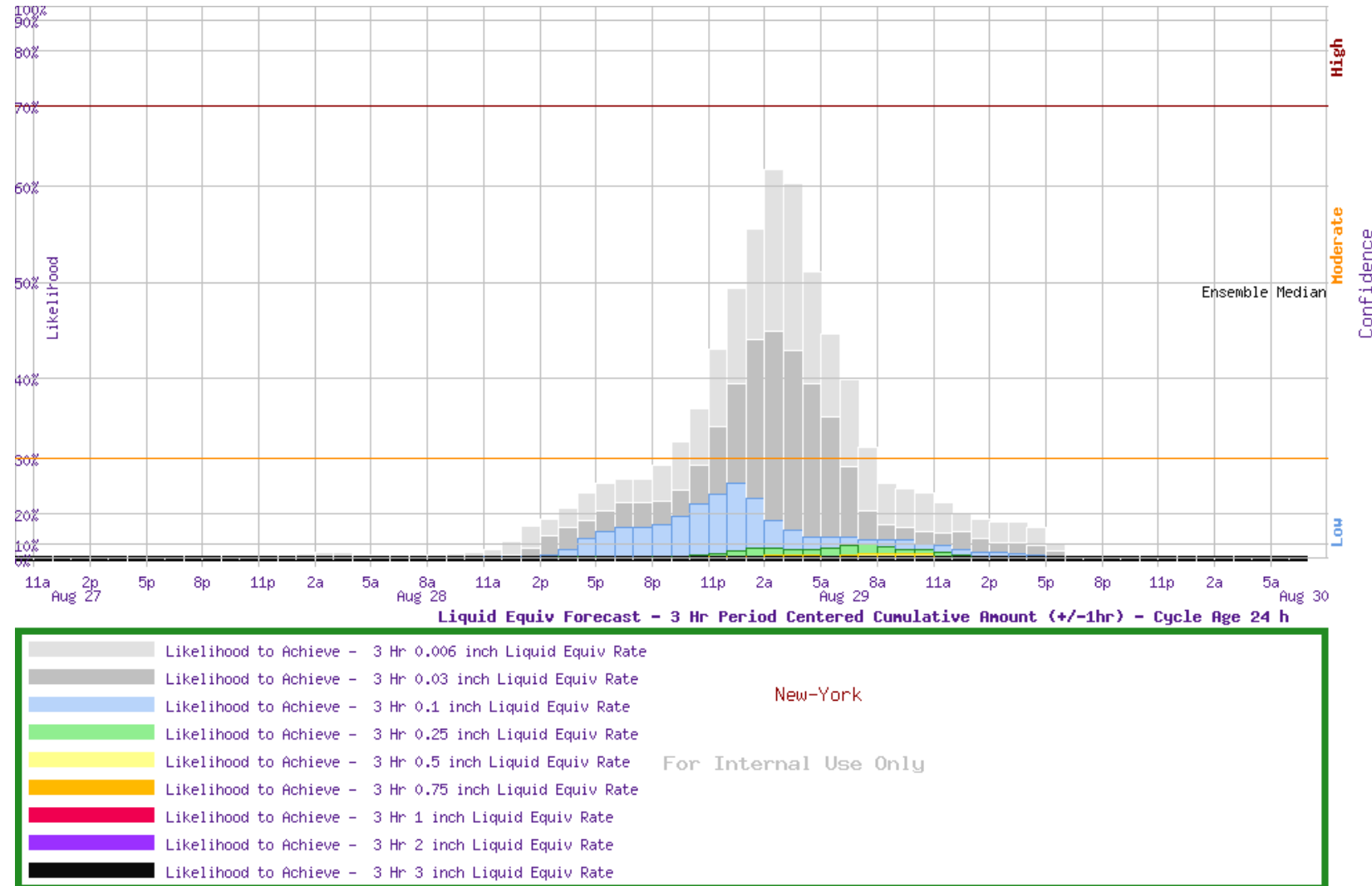
# Forecast Tendencies

- Trends over the past day from the grand ensemble

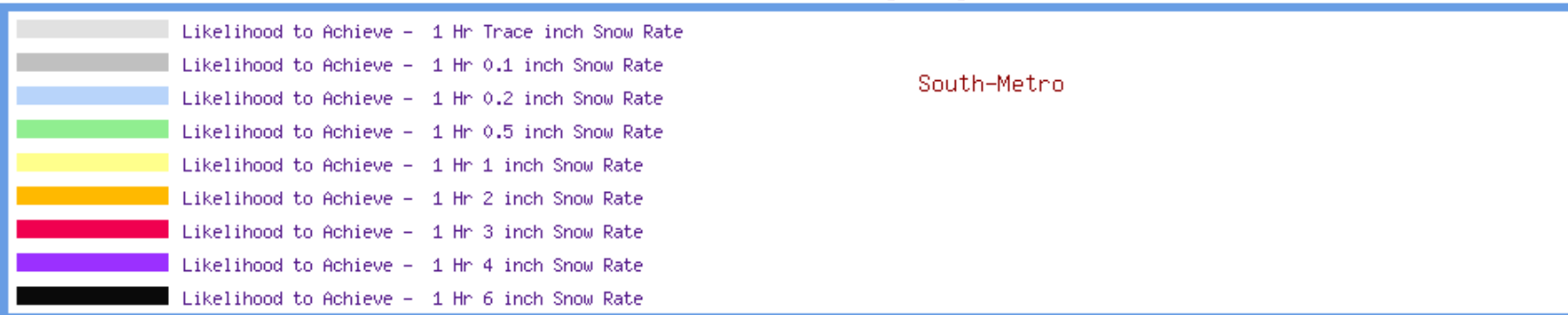
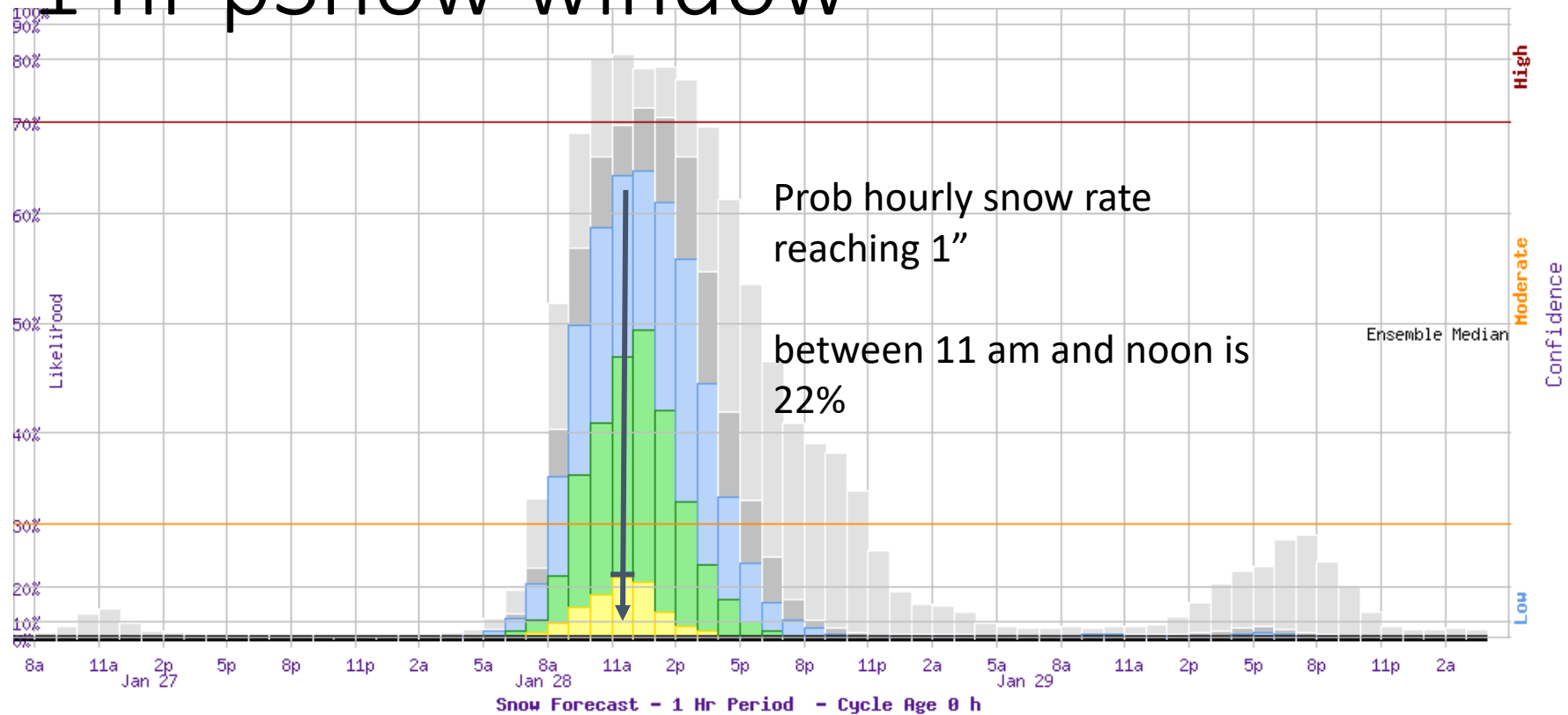


# Forecast Tendencies

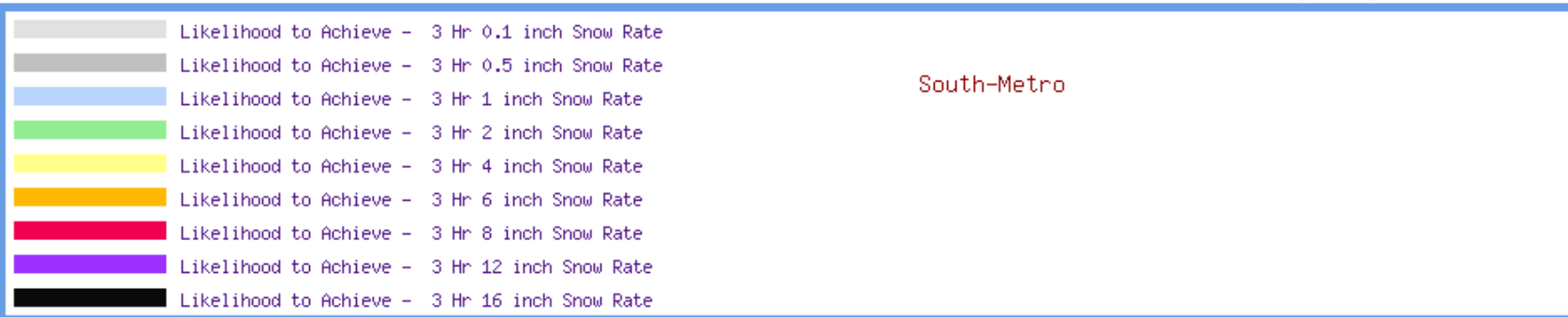
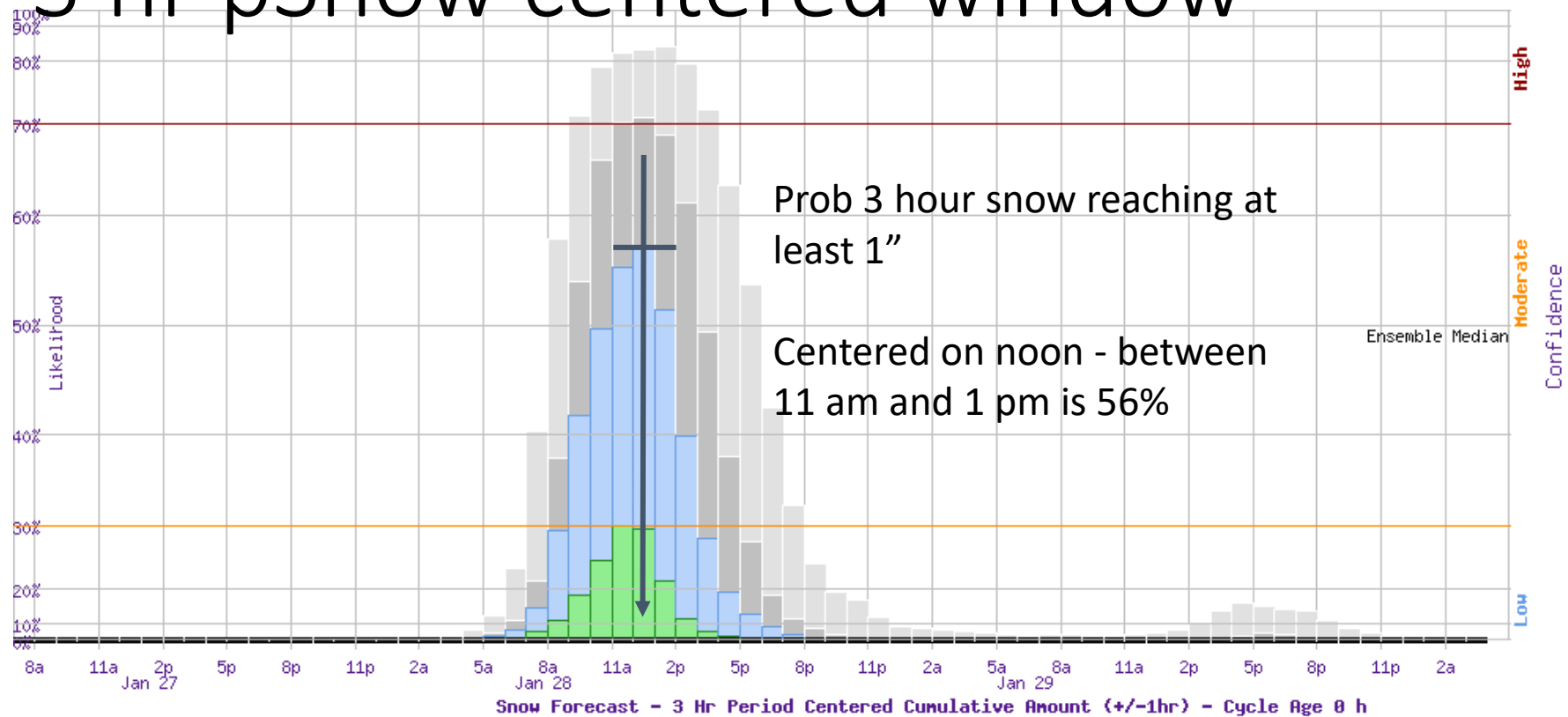
- Trends over the past day from the grand ensemble
- Very popular with forecasters in conveying changes to end users



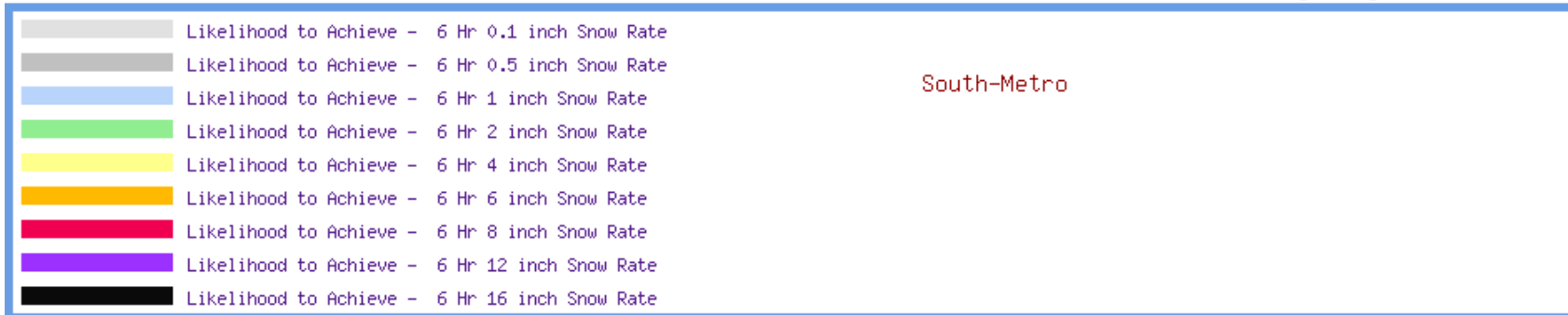
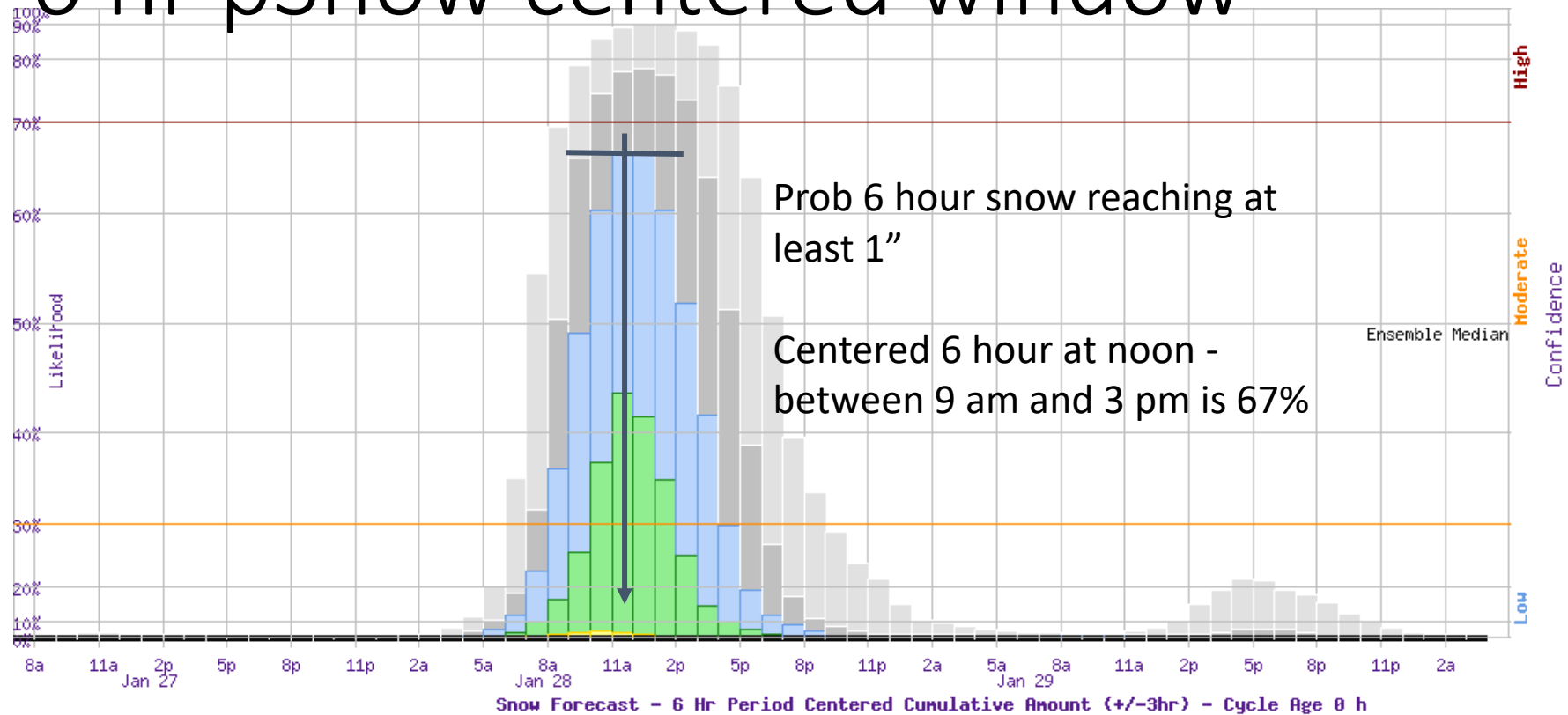
# 1 hr pSnow window



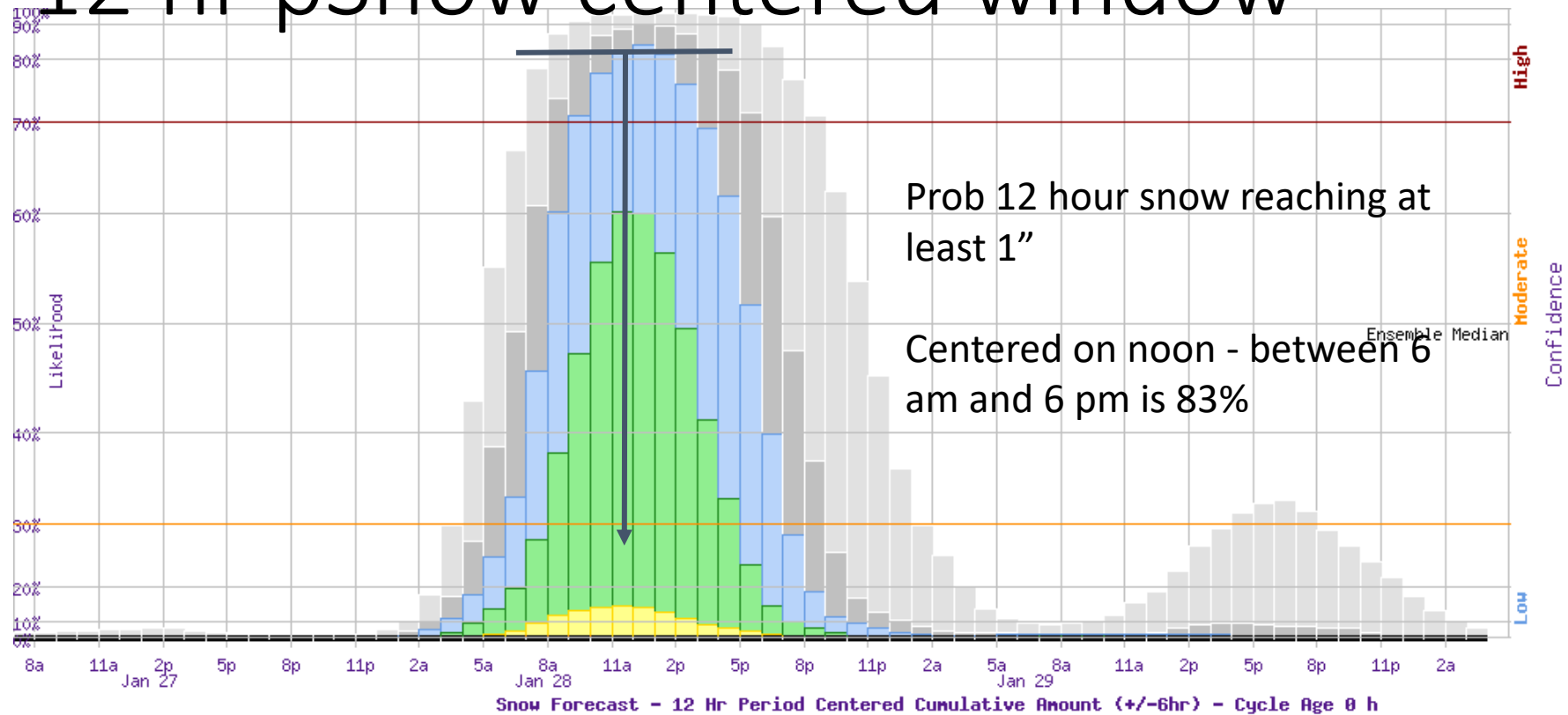
# 3 hr pSnow centered window



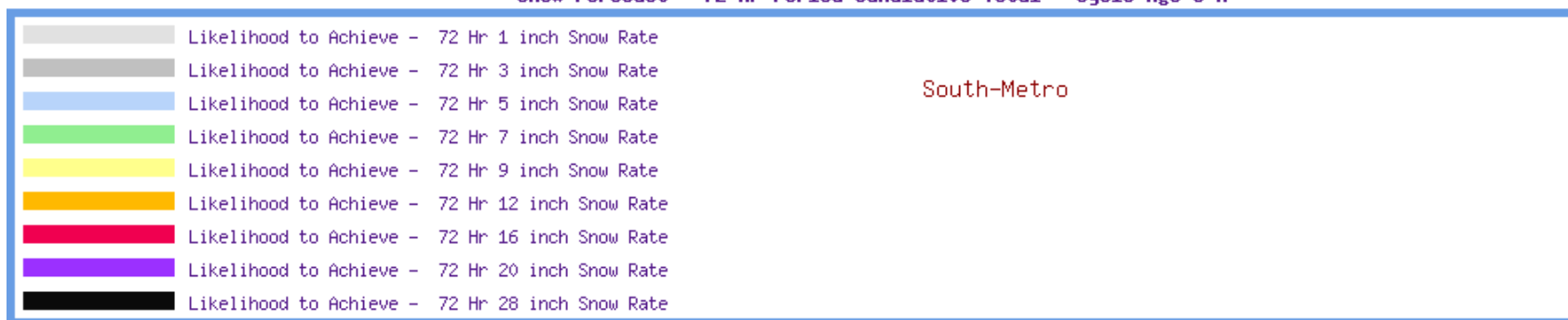
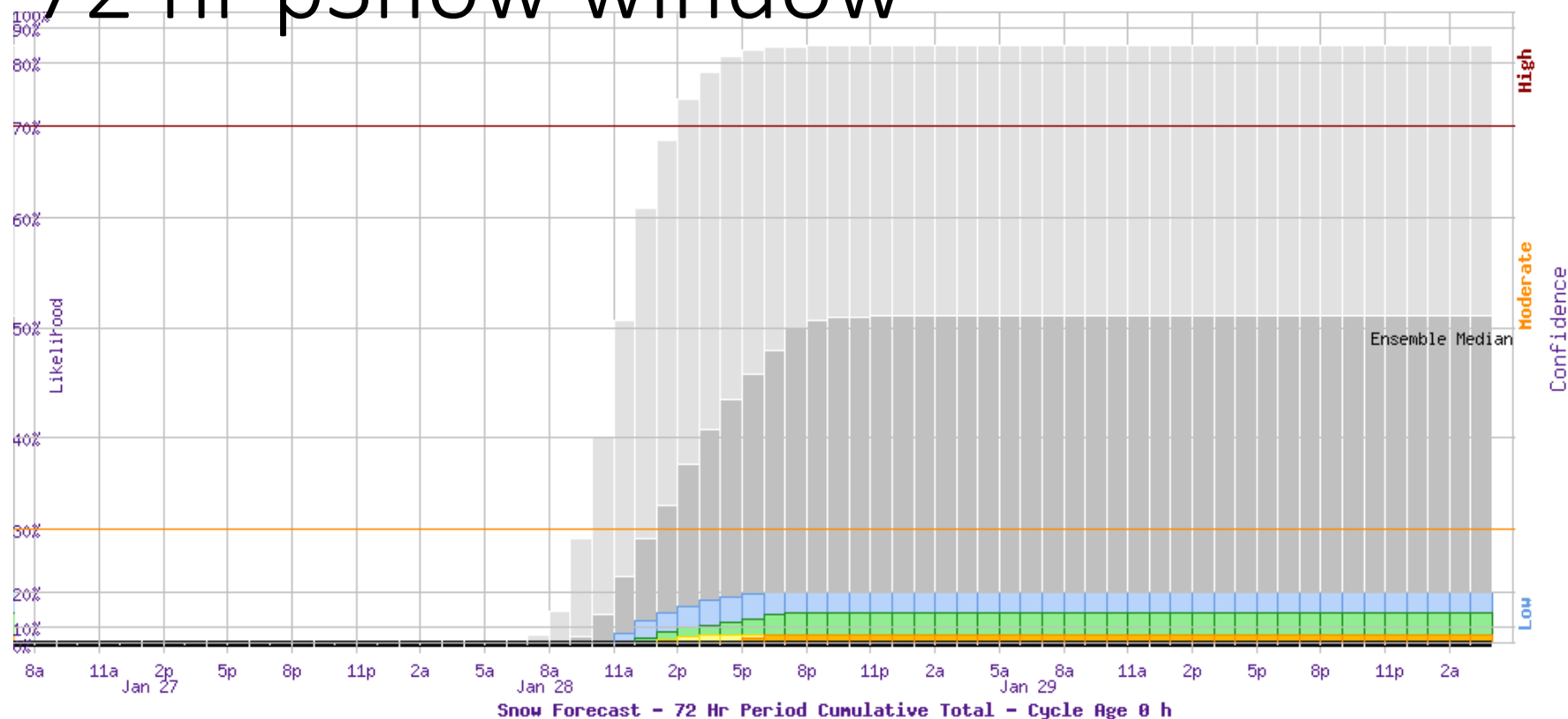
# 6 hr pSnow centered window



# 12 hr pSnow centered window



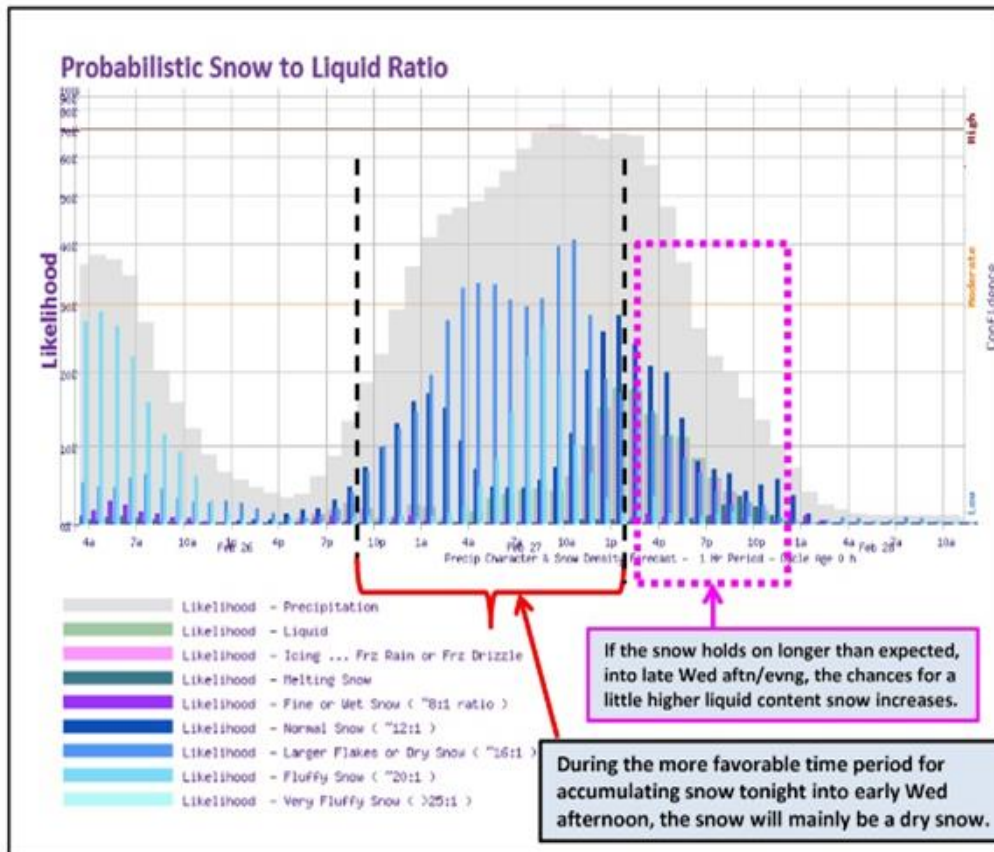
# 72 hr pSnow window



# Snow Liquid Ratio (SLR)

## Weather Overview:

- *Early This Morning* – Scattered light snow or flurries will produce nothing more than a dusting prior to 10 AM this morning.
- *Late Tonight Thru Wed Afternoon* – Light snow is expected. There is a 60% chance that total snowfall will range from 1 to 2 inches. The better chances for higher snow totals look to be north of DTW at this time.

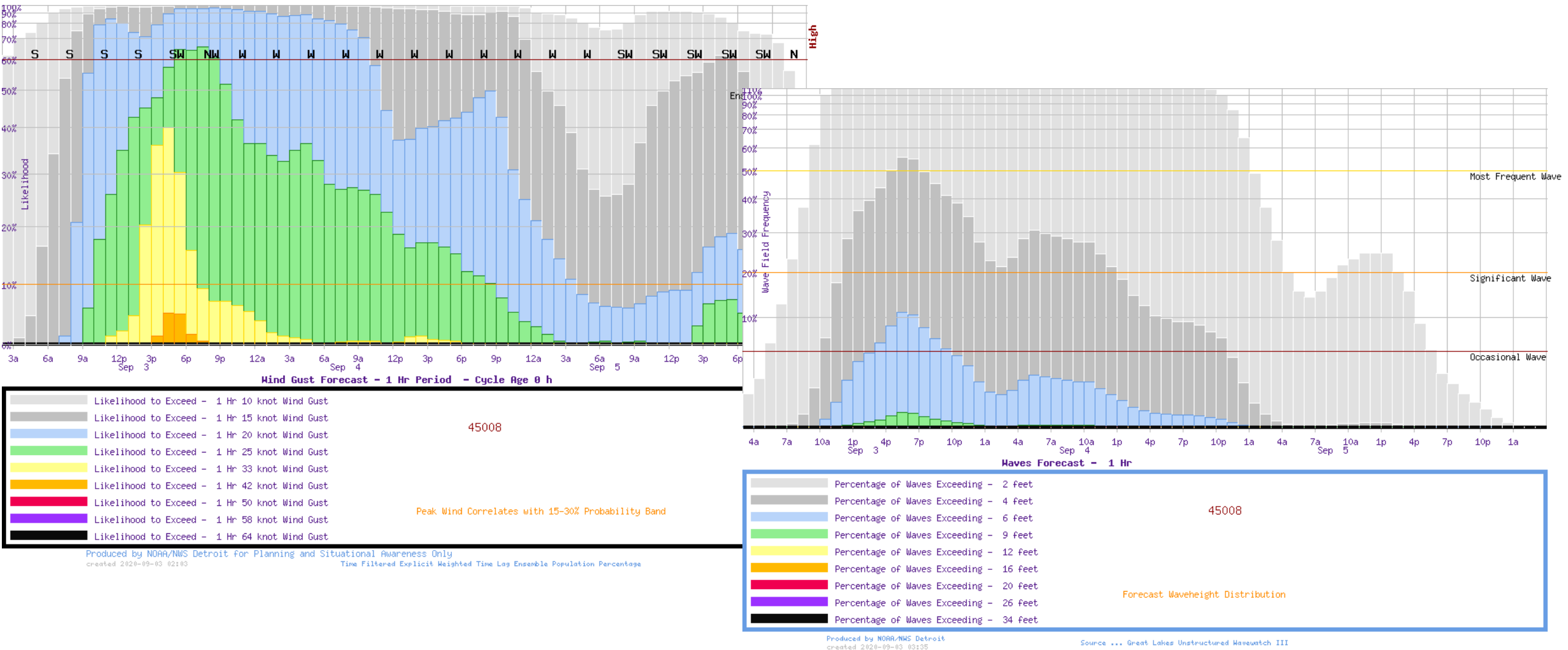


Gray is the total probability of precipitation (note the scale is compressed at the top).

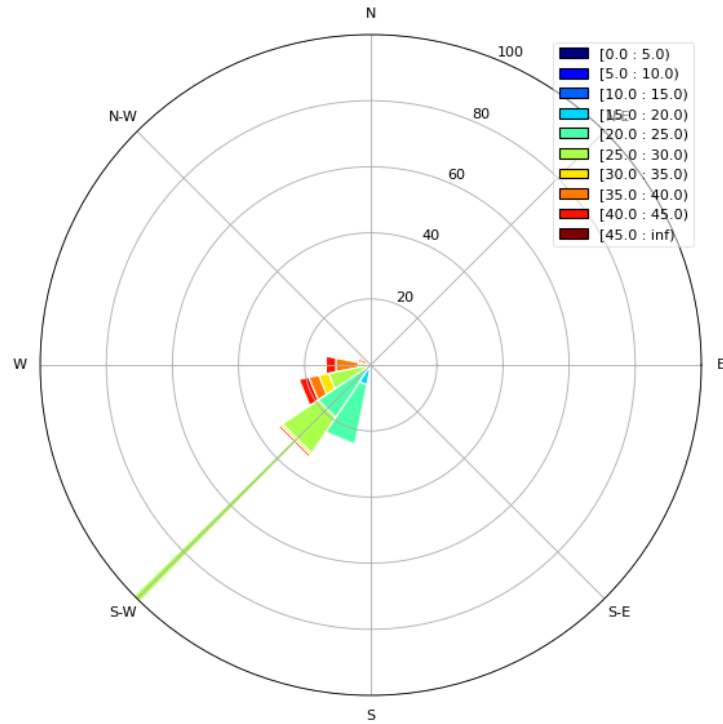
All the other colors in the column for each hour must add up to the total probability of precipitation.

This graphic, whenever used, will be annotated with trends, and the most likely character of the precipitation.

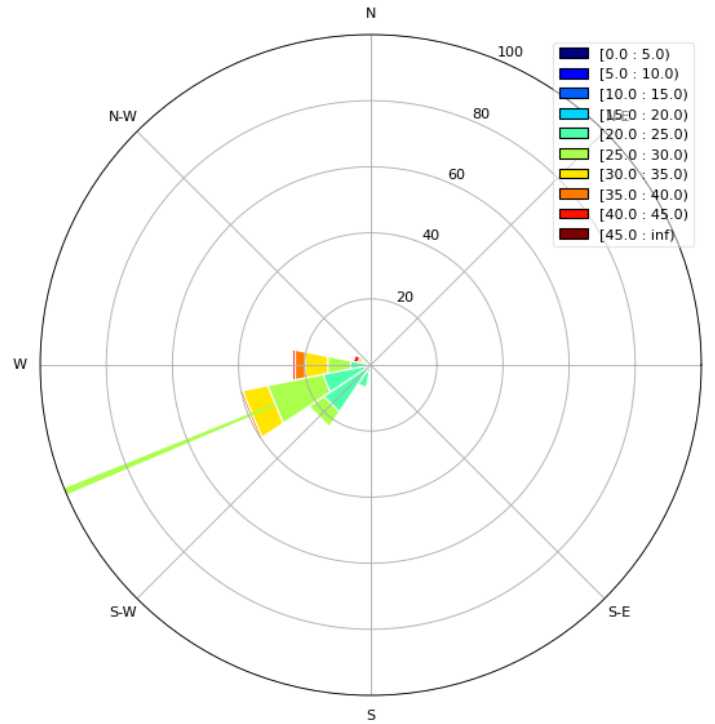
# Forecast Decision Aids – Marine



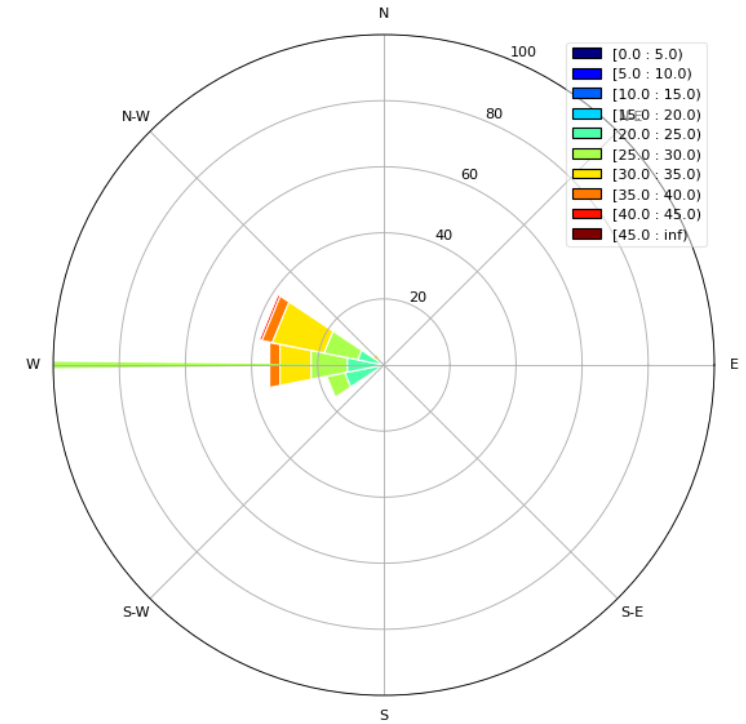
Ensemble Gusts @ 45008 - valid 2020-09-03 17:00:00EDT  
Wnd Dir Median (spoke) and Probs (%) graduated by Gust (knots)



Ensemble Gusts @ 45008 - valid 2020-09-03 18:00:00EDT  
Wnd Dir Median (spoke) and Probs (%) graduated by Gust (knots)



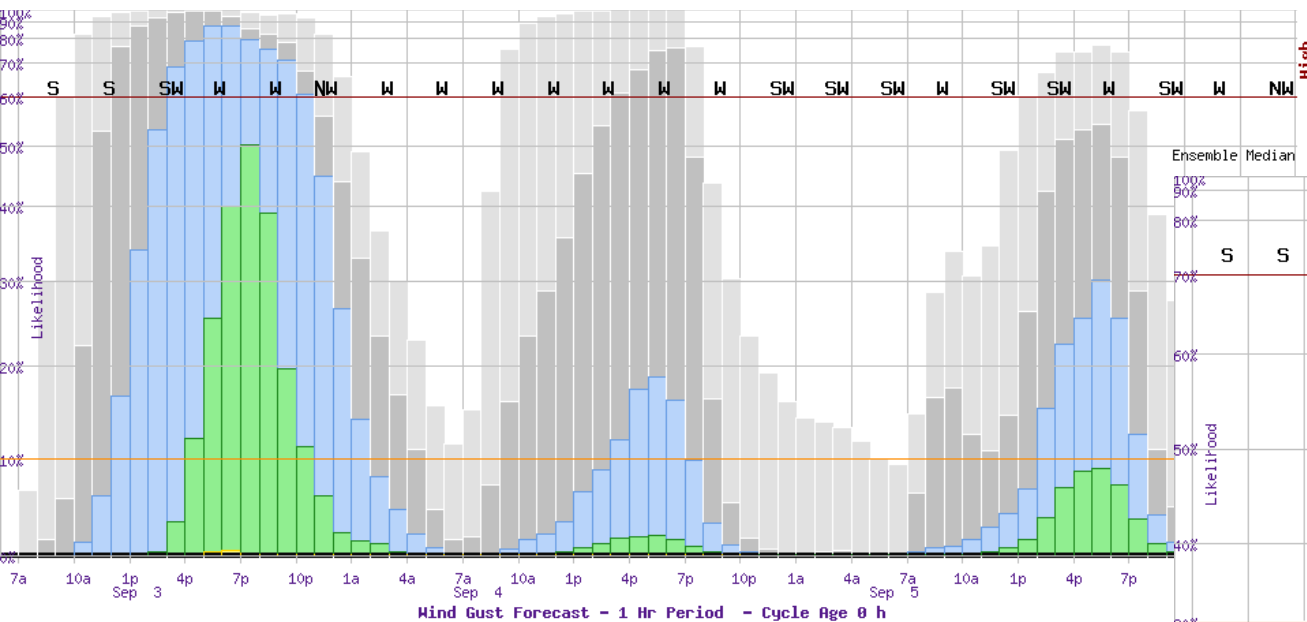
Ensemble Gusts @ 45008 - valid 2020-09-03 20:00:00EDT  
Wnd Dir Median (spoke) and Probs (%) graduated by Gust (knots)



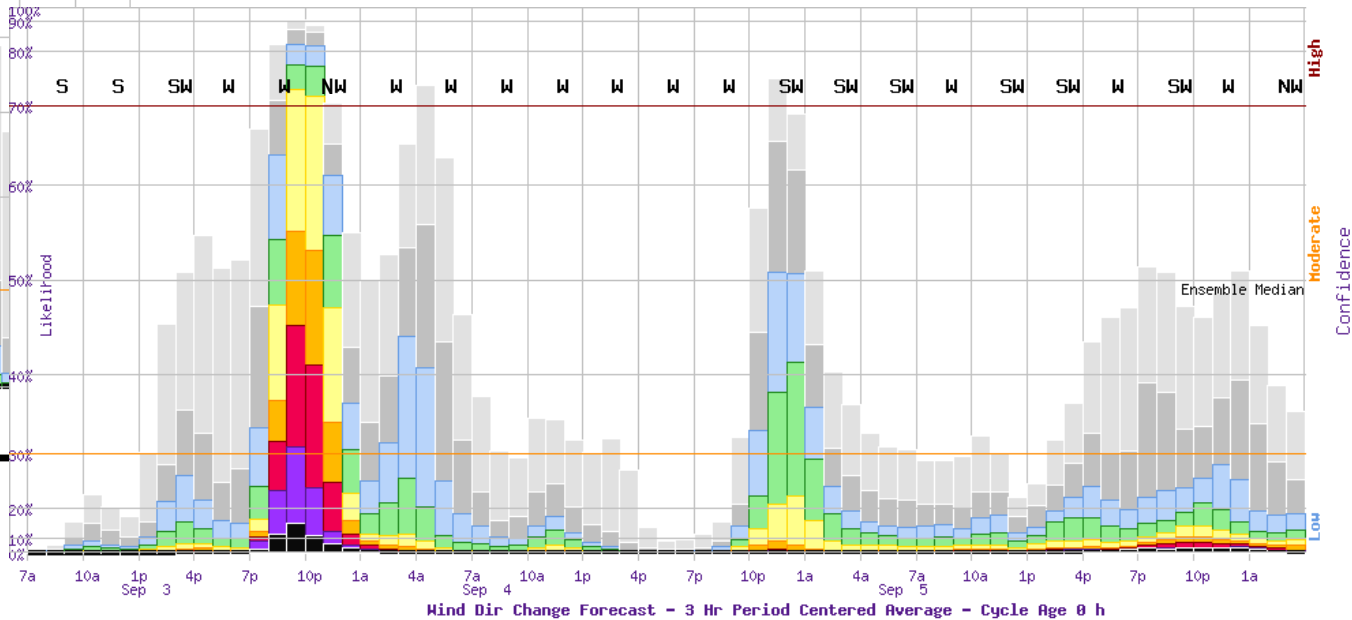
# Wind Rose - Marine

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# Forecast Decision Aids – Wind Direction Delta



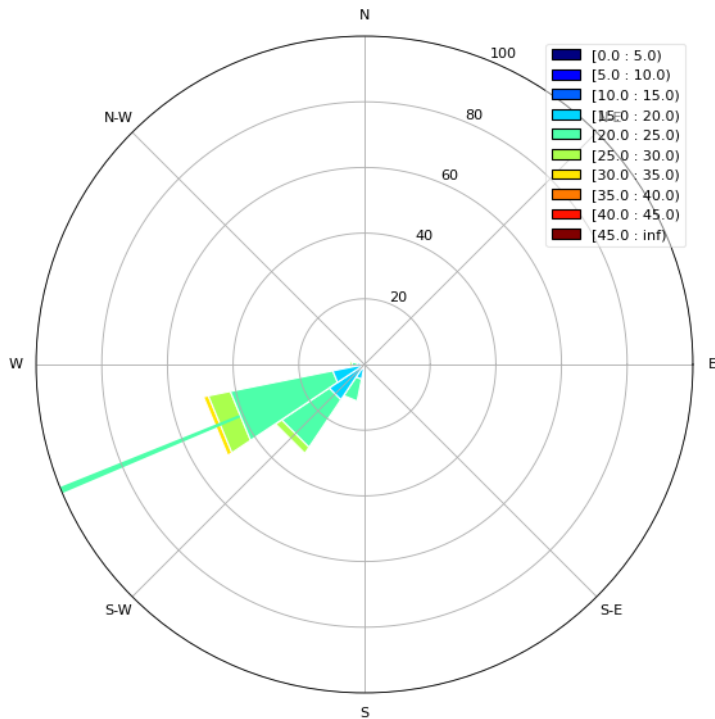
Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
created 2020-09-03 06:01 Time Filtered Explicit Weighted Time Lag Ensemble Population Percentage



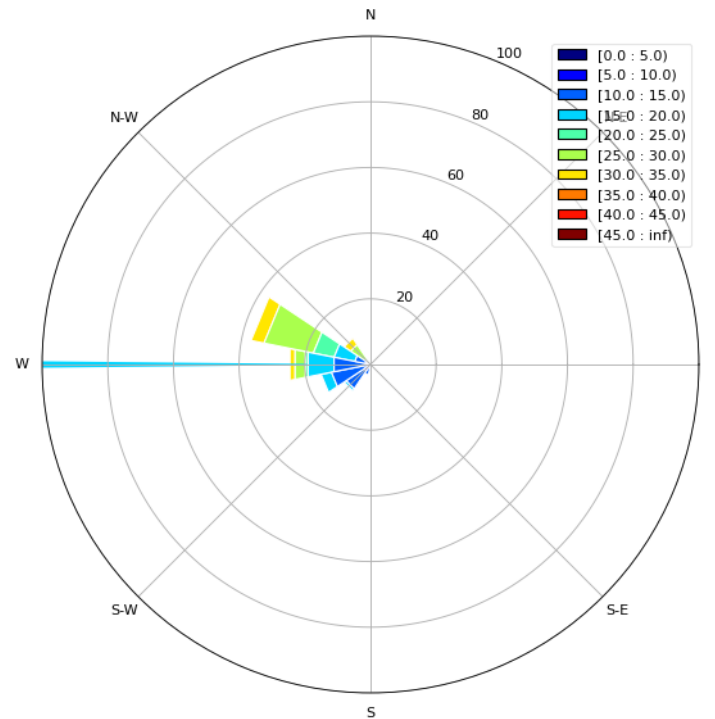
Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
created 2020-09-03 06:01 Time Filtered Explicit Weighted Time Lag Ensemble Population Percentage

# Wind Rose

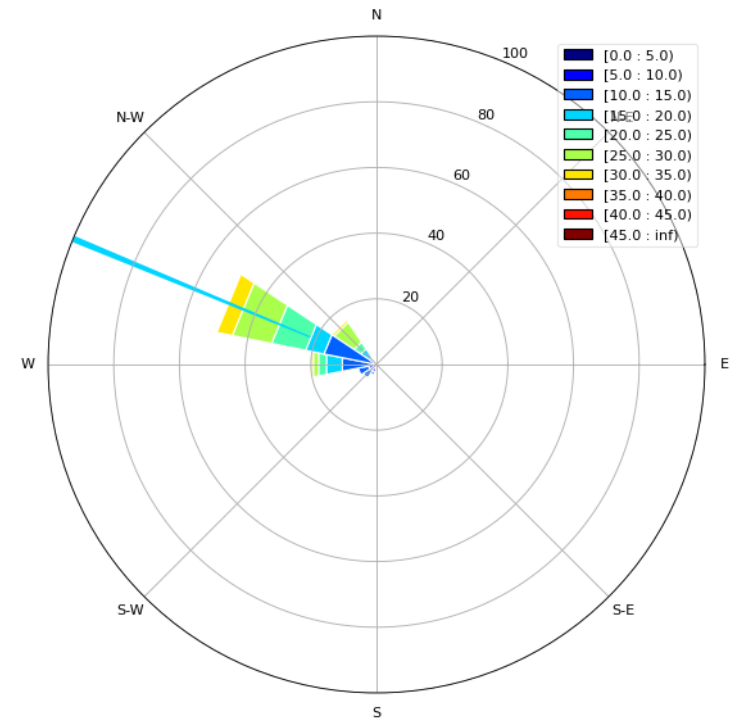
Ensemble Gusts @ KDTW - valid 2020-09-03 20:00:00Z  
Wnd Dir Ens Median (spoke) and Probs (%) graduated by Gust (kts)



Ensemble Gusts @ KDTW - valid 2020-09-04 00:00:00Z  
Wnd Dir Ens Median (spoke) and Probs (%) graduated by Gust (kts)

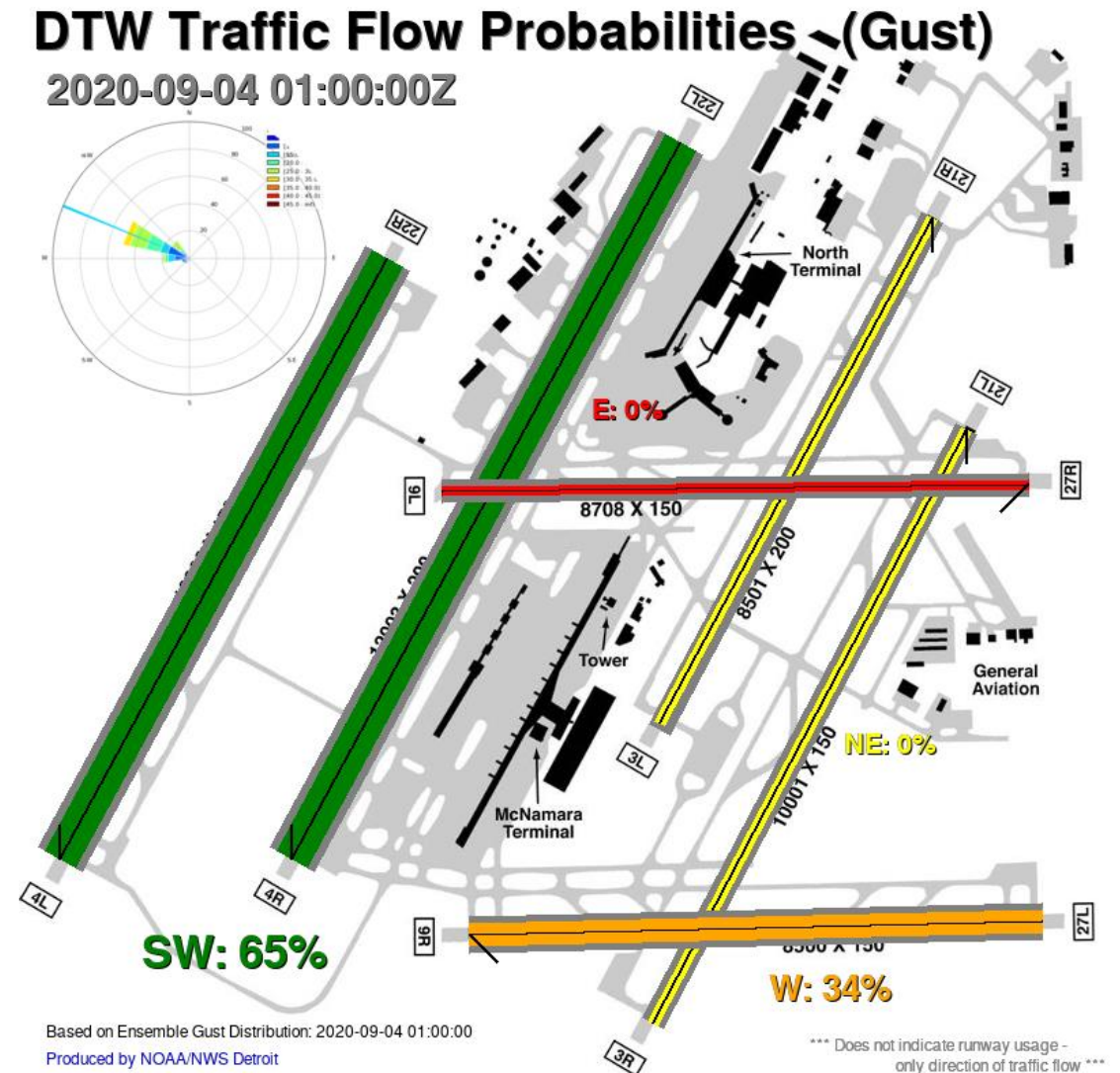


Ensemble Gusts @ KDTW - valid 2020-09-04 01:00:00Z  
Wnd Dir Ens Median (spoke) and Probs (%) graduated by Gust (kts)

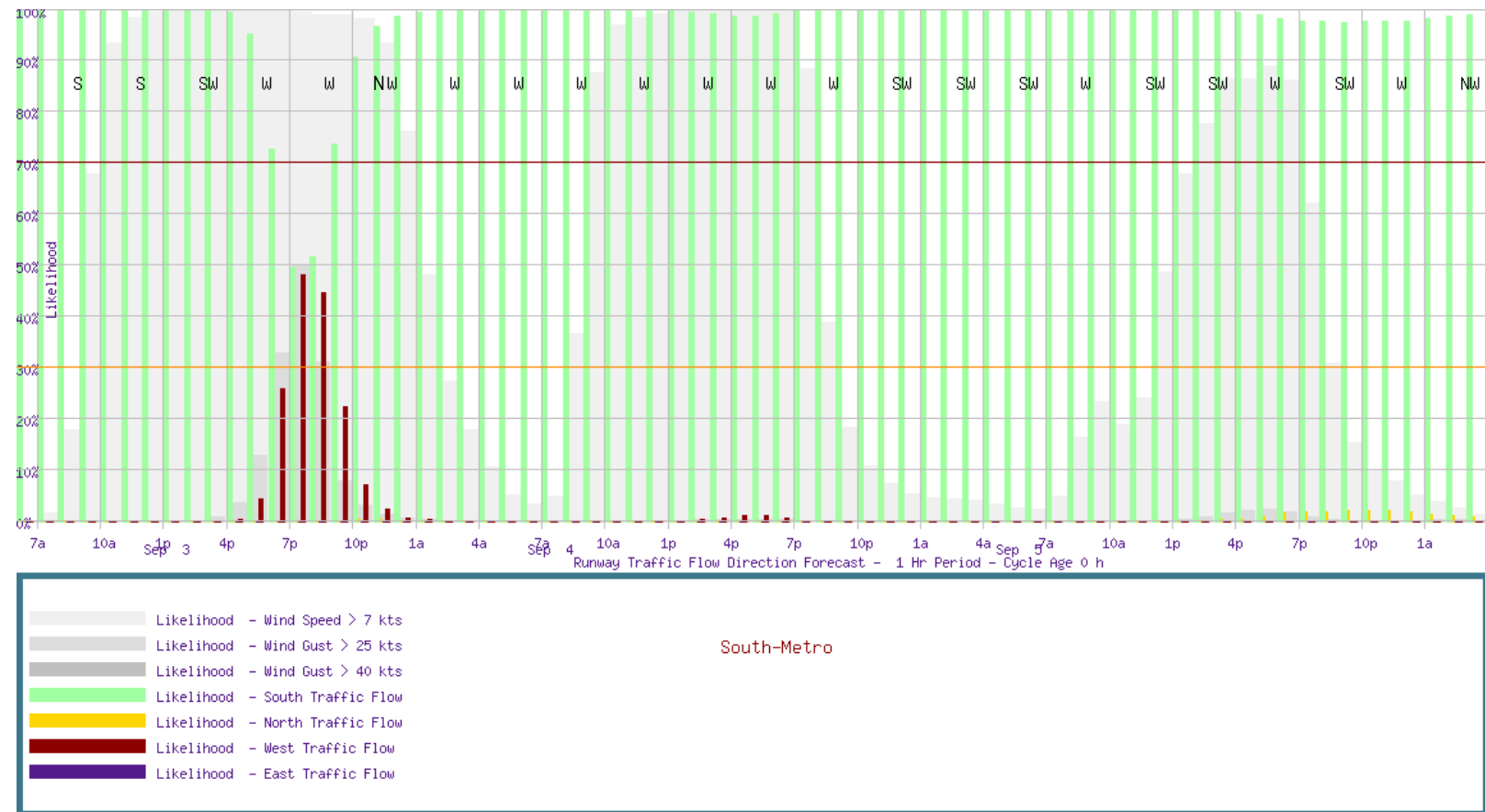
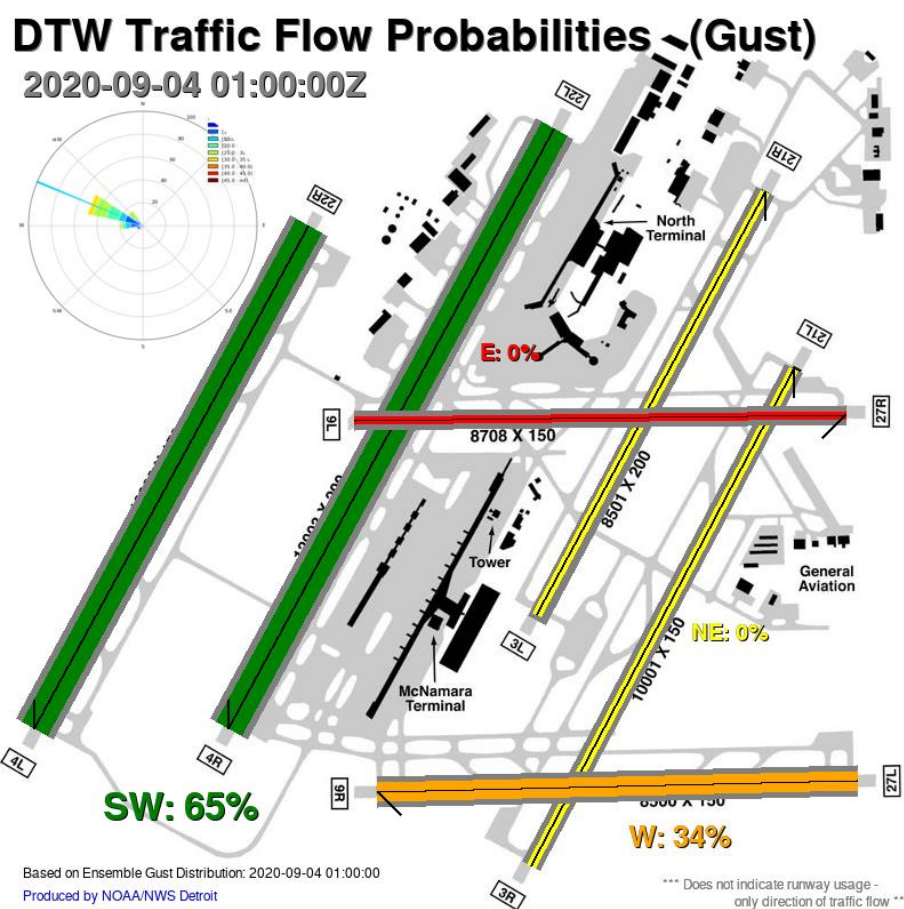


# Mapping to Definable Impacts

- Internal support for Center Weather Service Unit at FAA Cleveland Center
- Traffic Flow for airfield is highly directionally dependent for speeds greater than 6 knots
  - Impacts arrival flow rates and resultant National Airspace routing
- Map ensemble winds to airfield flow decision thresholds



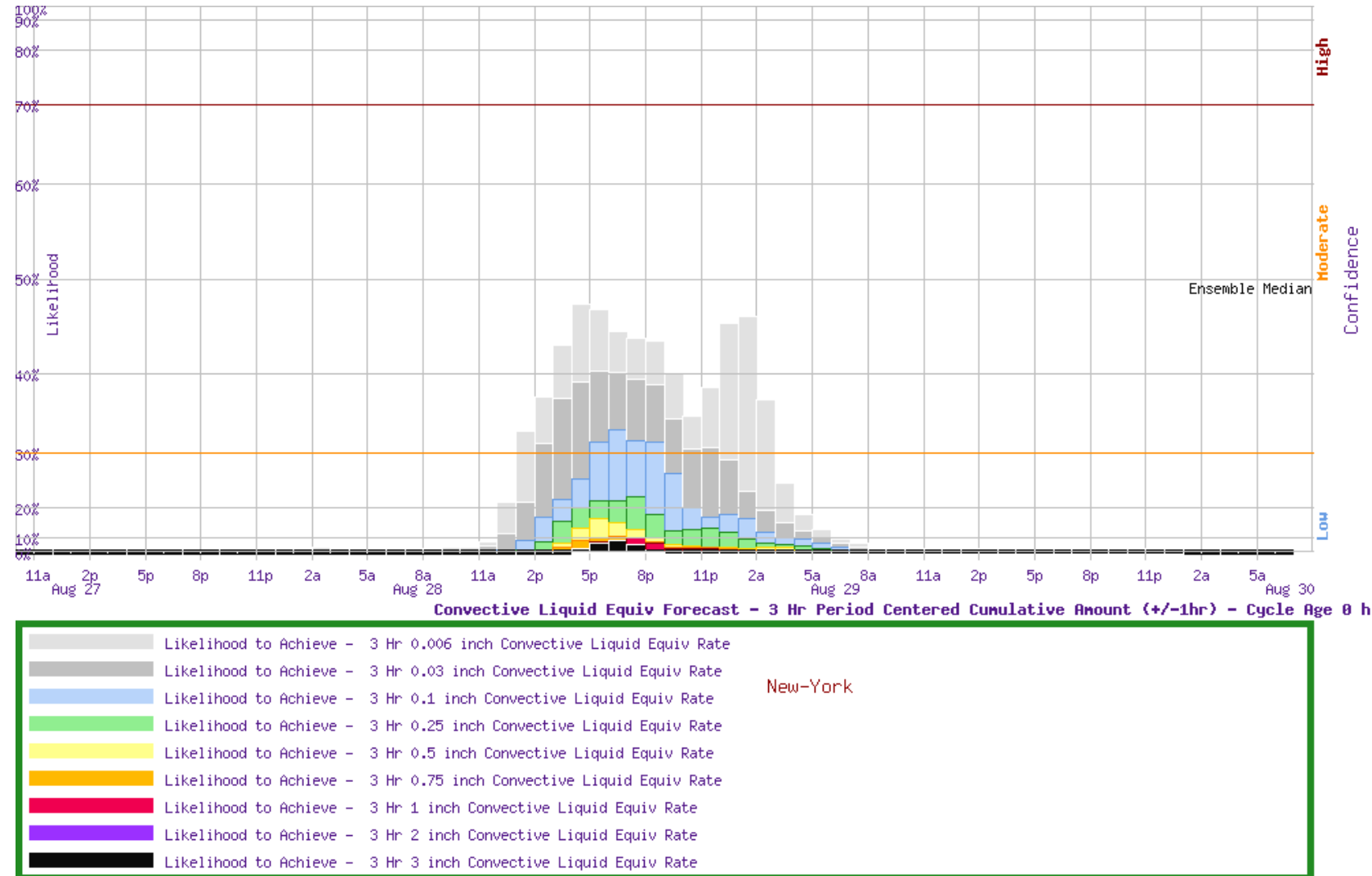
# Forecast Decision Aids – Airport Traffic Flow



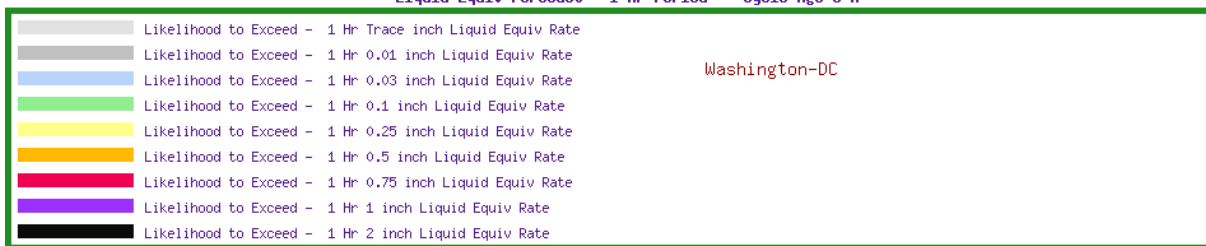
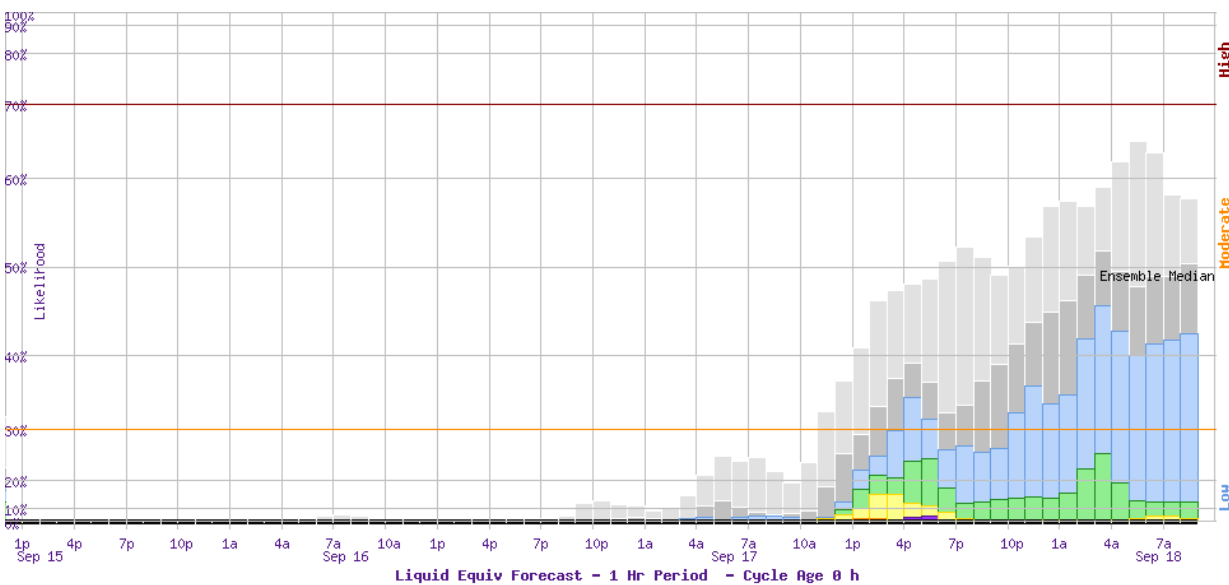
Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
created 2020-09-03 06:01 Time Filtered Explicit Weighted Time Lag Ensemble Population Percentage

# Conditional PQPF - Convection

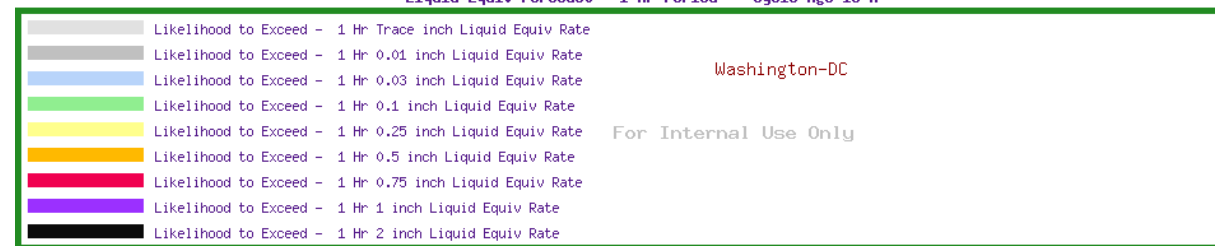
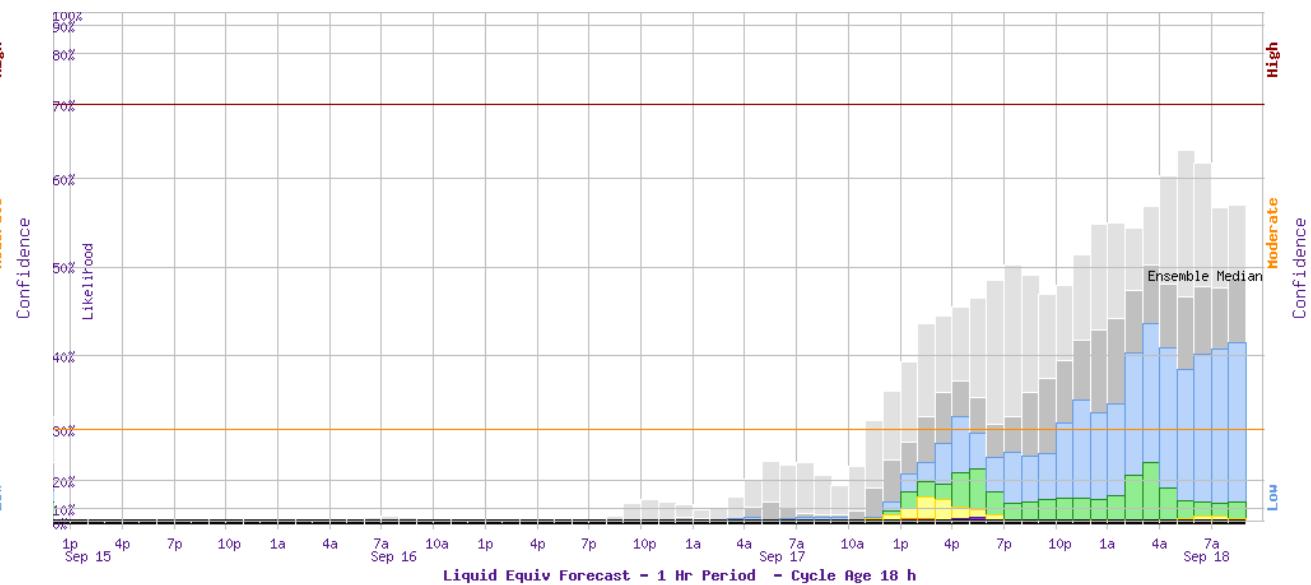
- Filter ensemble output using other diagnostics
- Example PQPF where MUCAPE > 100 J/kg



# 1h PQPF – DCA w/ animated trend

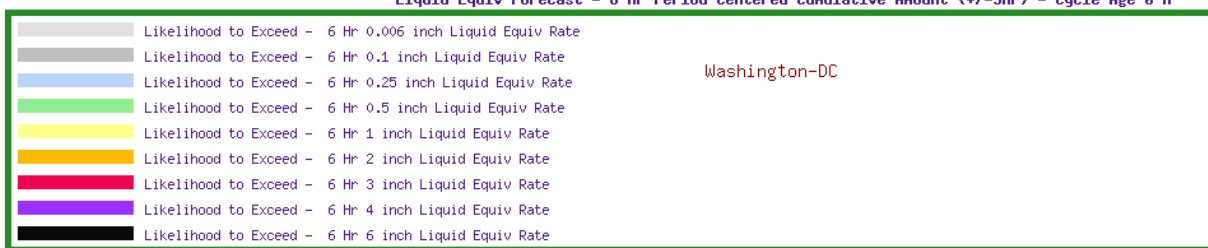
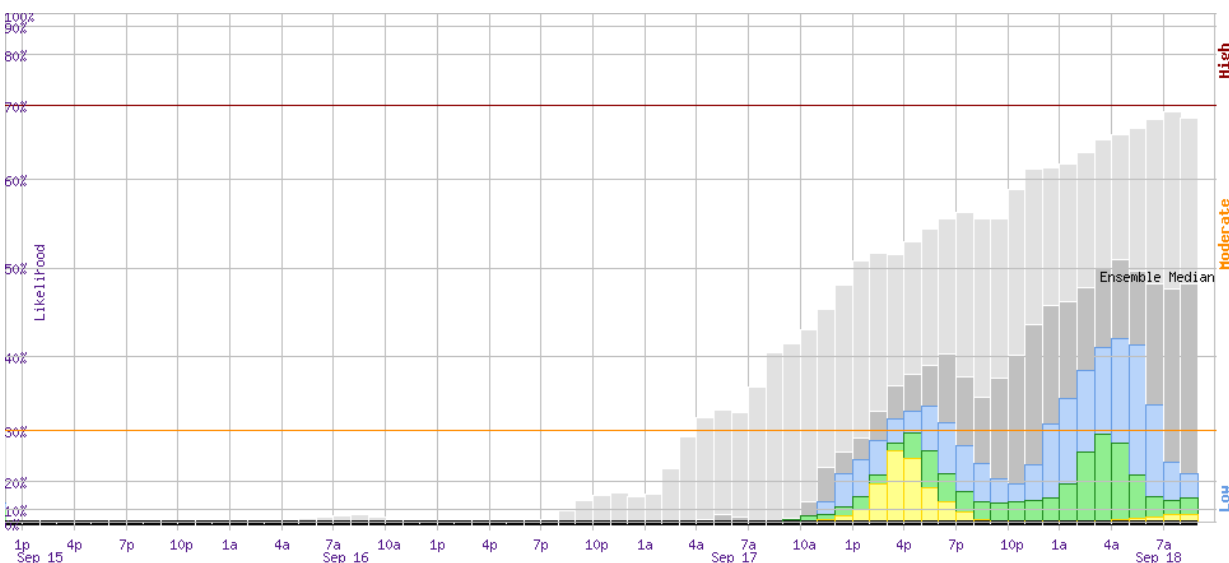


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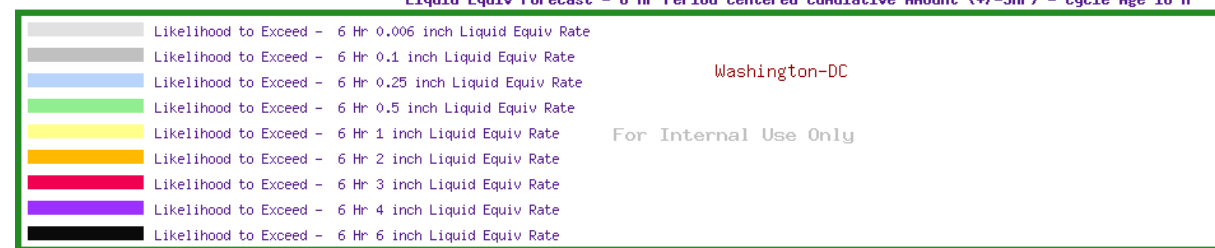
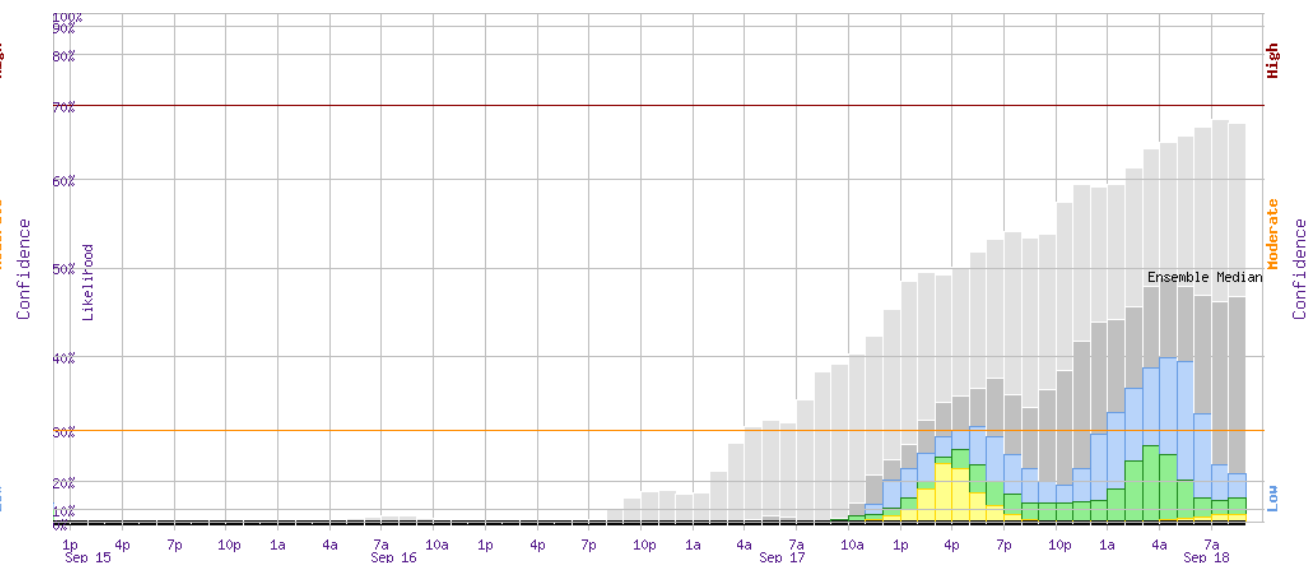


Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
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# 6h PQPF – DCA w/ animated trend

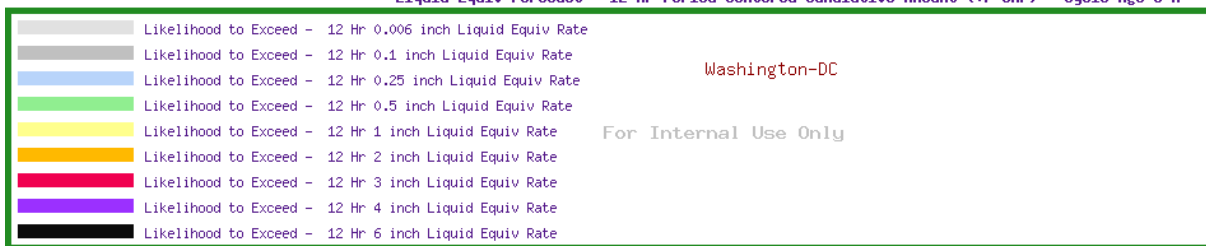
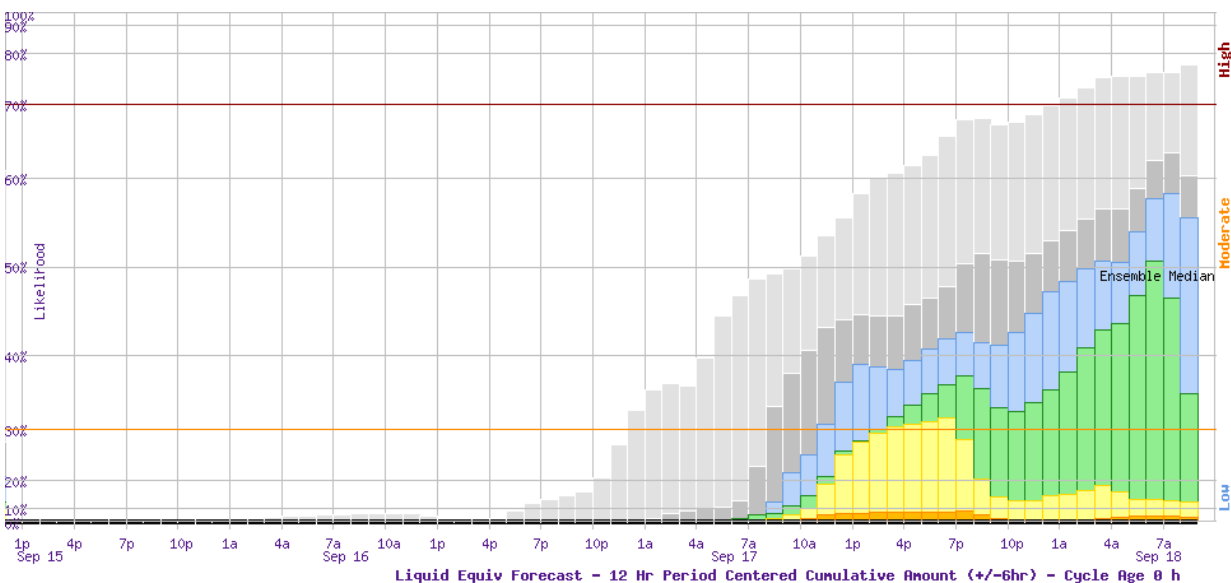


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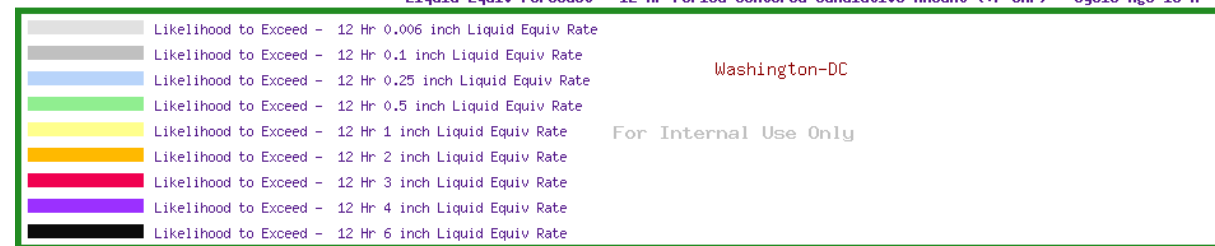
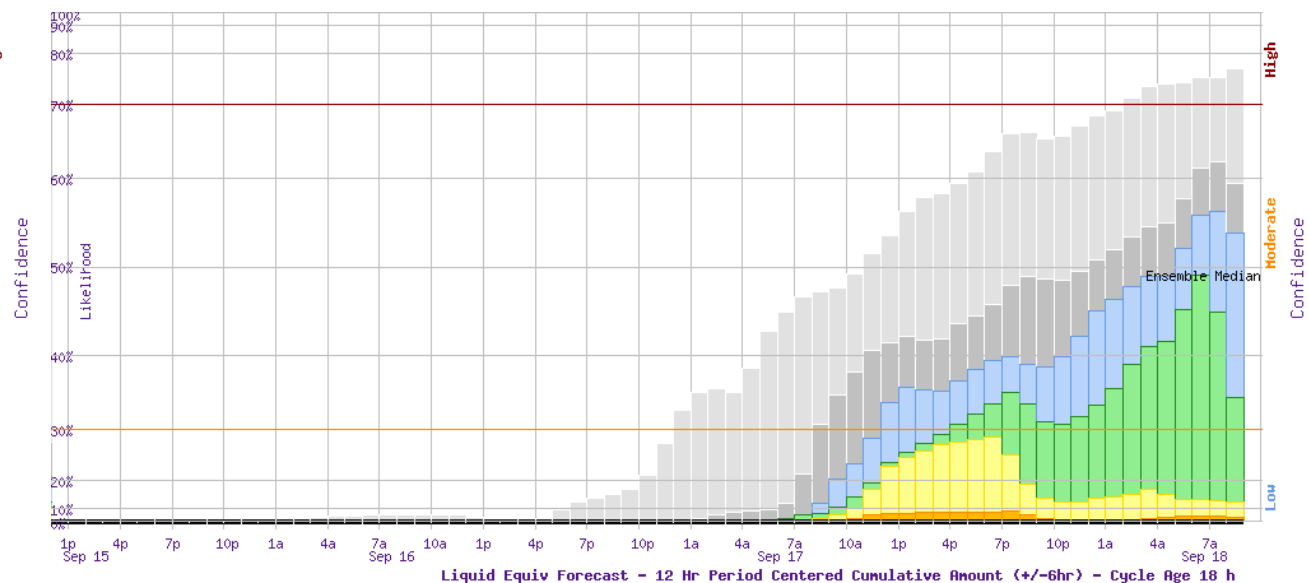


Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
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# 12h PQPF – DCA w/ animated trend

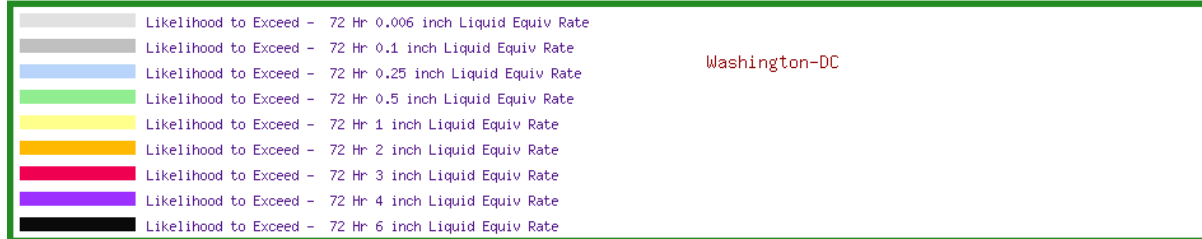
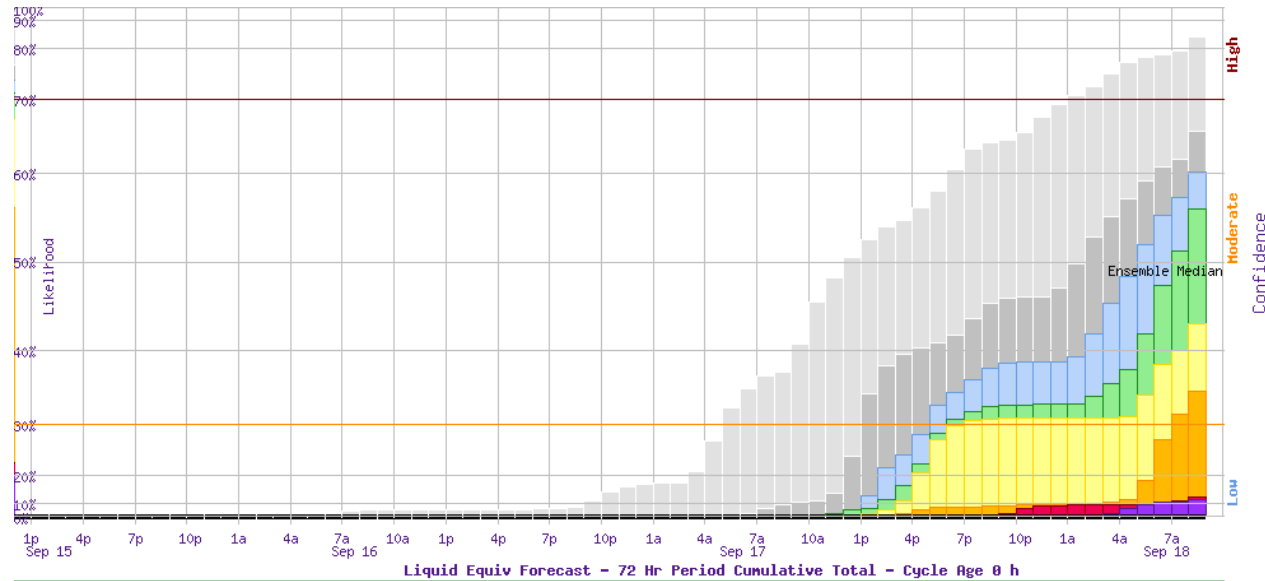


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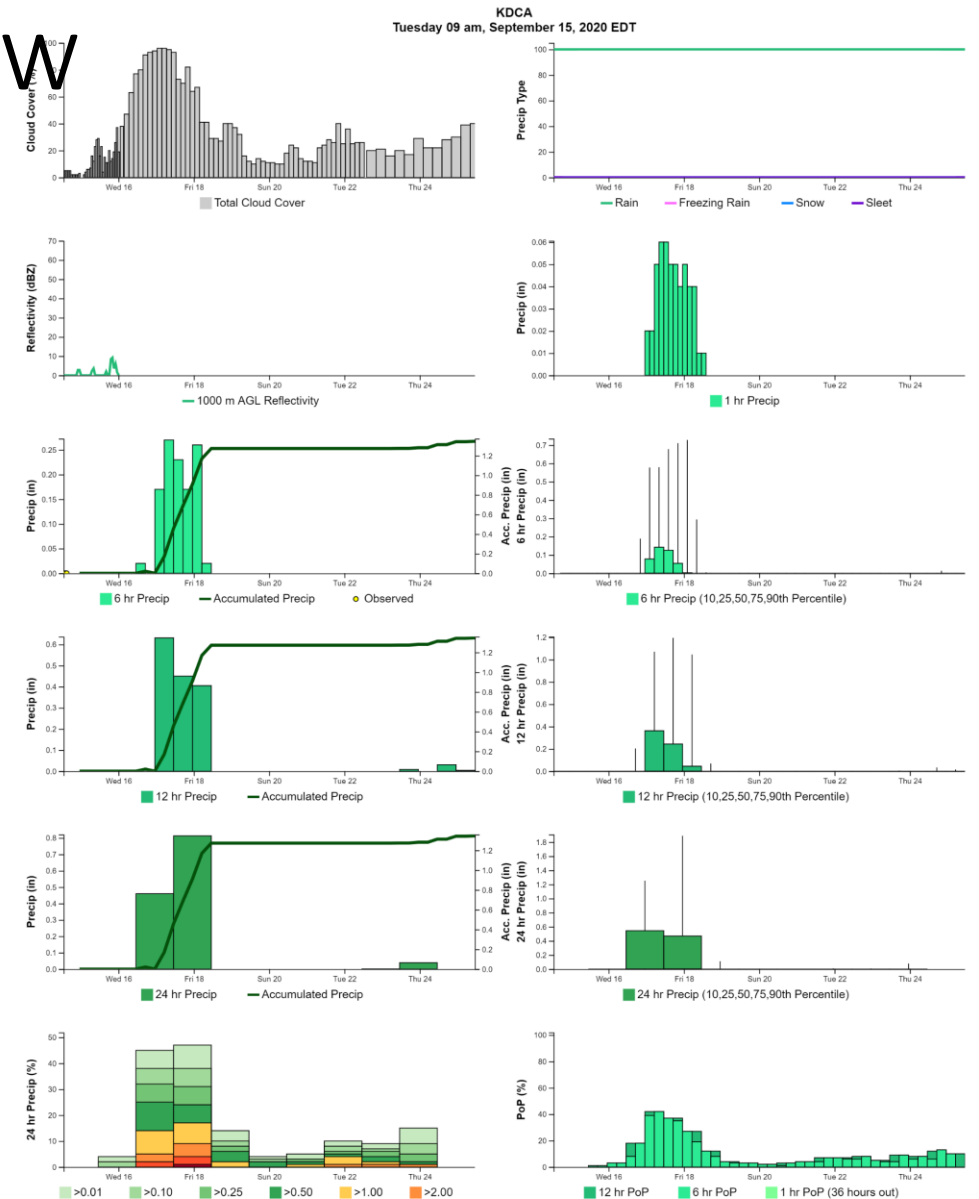


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created 2020-09-15 12:07 Time Filtered Explicit Weighted Time Lag Ensemble Population Percentage

# 72h PQPF – DCA + NBM view



Produced by NOAA/NWS Detroit for Planning and Situational Awareness Only  
created 2020-09-15 12:07 Time Filtered Explicit Weighted Time Lag Ensemble Population Percentage



# Some Considerations

- Layered information content provides greater context
  - Must maintain constant amplitude space to allow for comparative assessments
- Timelines meet vast majority of WFO client needs more directly
- While calibration is nice – ensemble information content depth has great value
  - Users will use uncalibrated single solution data in the absence of useable ensemble data
- Interpretative services must include conditionality to aid decision process – includes informing the forecast process
- Simplicity is not desired – rather clarity
  - Spectra of outcomes is necessary to enable decision-makers to appropriately apply portions of action plans or playbooks
- Forecast spectra tendencies provide important additional value
- Flexibility to extract and ask questions of the data is paramount

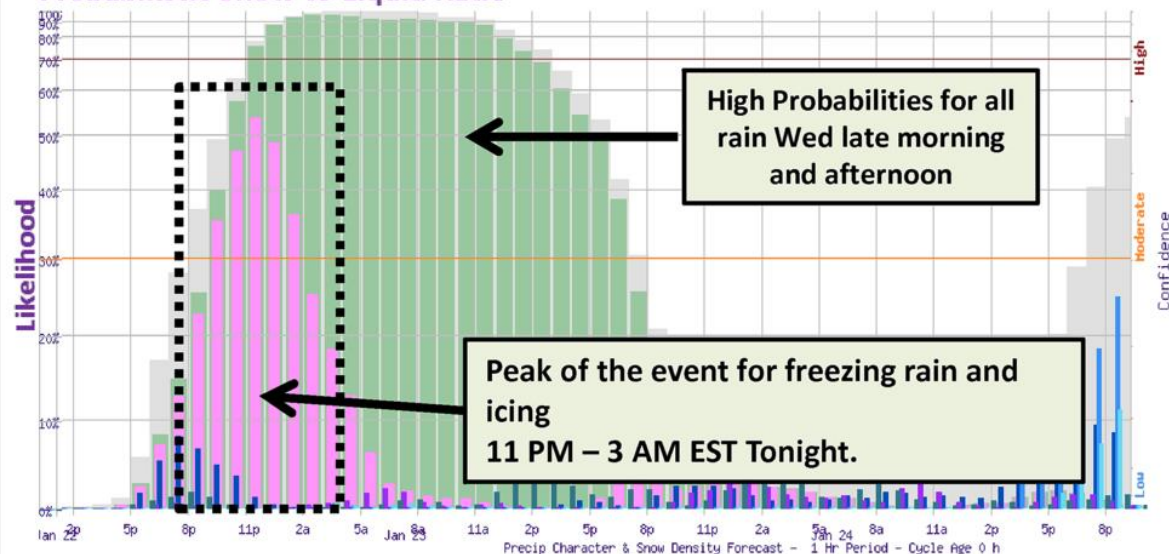
# Example Briefings to WCAA

Airport Ground Operations Winter Weather Support

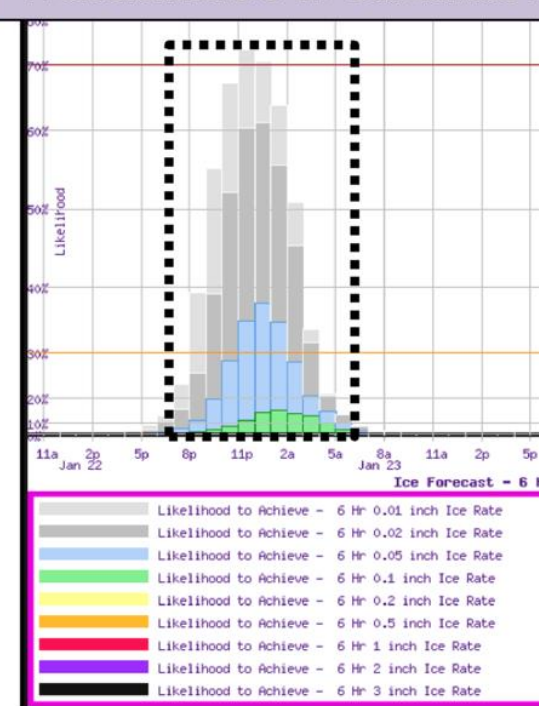
## Narrative For Tonight & Early Wednesday

- Precipitation will spread across DTW this evening. A brief period of snow will be possible at the start of the event.
- Latest indications are that a good chunk of the precipitation will fall tonight as freezing rain.
- Window for freezing rain is between 9 PM – 5 AM EST. Peak of the event is expected to occur between 11 PM – 3 AM EST.
- Total accumulations of ice in excess of 0.10 inch is possible.
- Precipitation will become warm rain by 5 AM EST.

### Probabilistic Snow to Liquid Ratio



### Probabilistic 6 hr Guidance for Ice



Probabilities are increasing rapidly in support of freezing rain at DTW tonight.

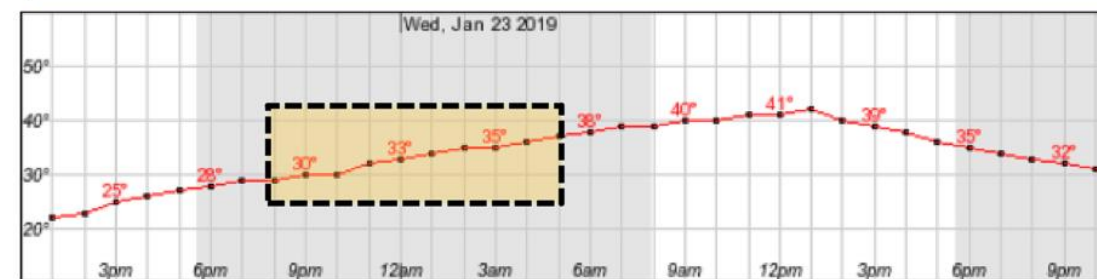
The likelihood for icing of reaching and exceeding 0.10 inch is increasing.

Greatest time window for freezing rain is 9 PM – 5 AM EST.

Uncertainty does exist with how exactly how fast surface air temperatures will rise and how cold pavement temps will respond.

### Temperatures:

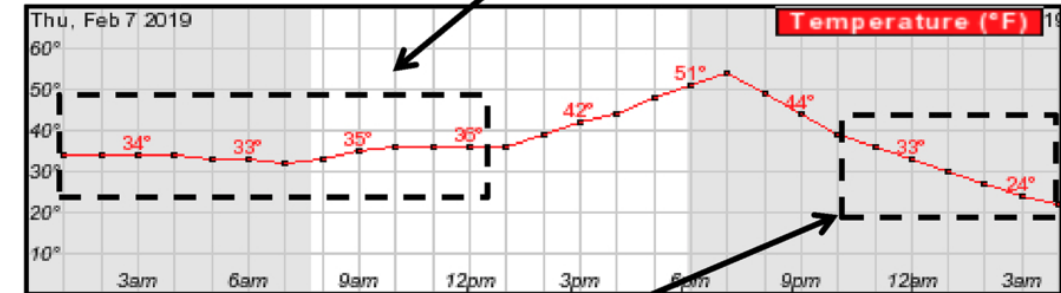
- Uncertainty exists with how fast temperatures will warm. Latest forecast information slows down the timing of above freezing temps.
- Latest forecast information suggests air temperatures not rising above the freezing mark until 3 AM EST.



## Weather Overview

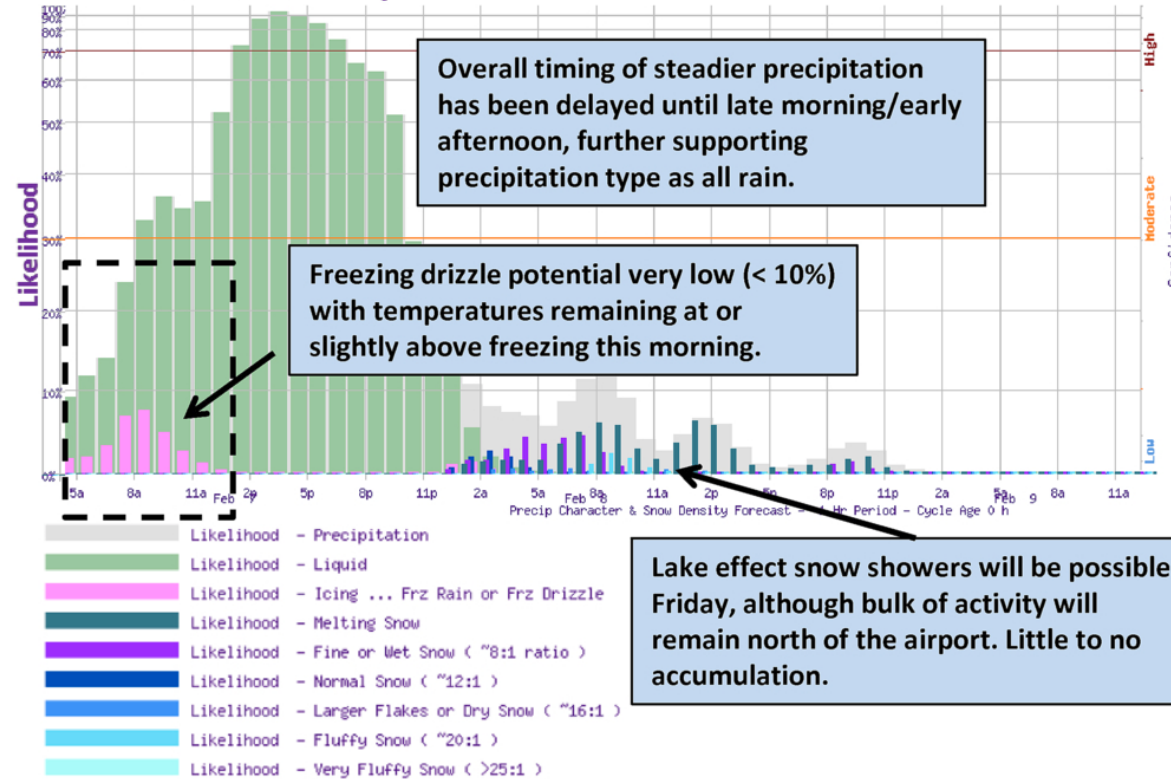
- Strong storm system will bring mainly rain to the airport today. Very low potential for freezing drizzle early this morning, as temperatures remain at or slightly above freezing.
- Gusty west winds expected this evening into Friday morning, especially 7pm-1am. Peak gusts up to 40 mph possible.
- Temperatures will fall rapidly below freezing after midnight tonight. After today's rain, there is a low potential for flash freezing of wet pavement surfaces.
- A few lake effect snow showers possible Friday with little to no accumulation.

Temperatures hover at or slightly above freezing this morning before warming well above freezing by noon.

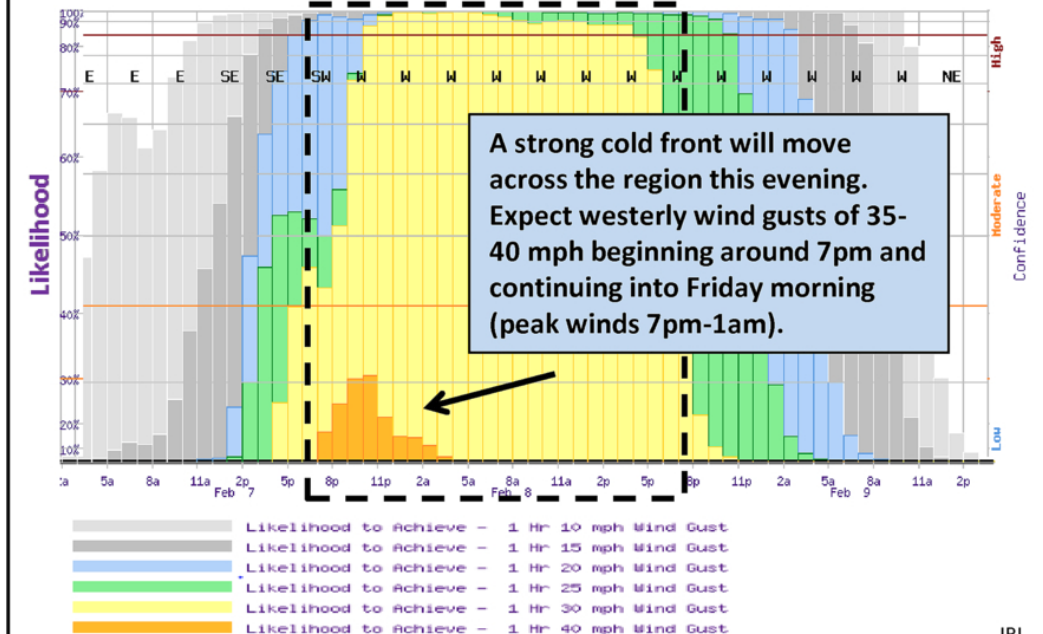


As temperatures rapidly fall below freezing after midnight tonight, potential for flash freeze of wet pavement. Confidence in this occurring is low as gusty winds may act to dry, rather than freeze any lingering moisture on pavement.

## Probabilistic Snow to Liquid Ratio



## Probabilistic 1 hr Guidance for Wind Gust



## Forecast Narrative (11/9) Friday & Friday night

### What we know

- Dynamic low pressure system will lift northeastward into the Great Lakes region Friday. Widespread light snow will impact portions of Southeast Michigan during the Fri 6 AM – 1 PM time window.
- Precipitation will then transition to numerous to scattered snow showers between 1 PM Friday – 7 AM Saturday.
- Best potential for snow accumulations will be to the west of U.S. 23 and north of I 96.

### What we do not know

- Uncertainty exists in the temperature profile Friday morning in the lower atmosphere over DTW. Potential is increasing that wet snowflakes will reach the ground. At this time, ground and surface air temperatures will be above freezing which suggests no snowfall accumulation at DTW.
- Where exactly the lake effect snow band will set up off of Lake Michigan Friday evening and Friday night. Current forecast trends suggest the lake effect banding will remain to the north of DTW.

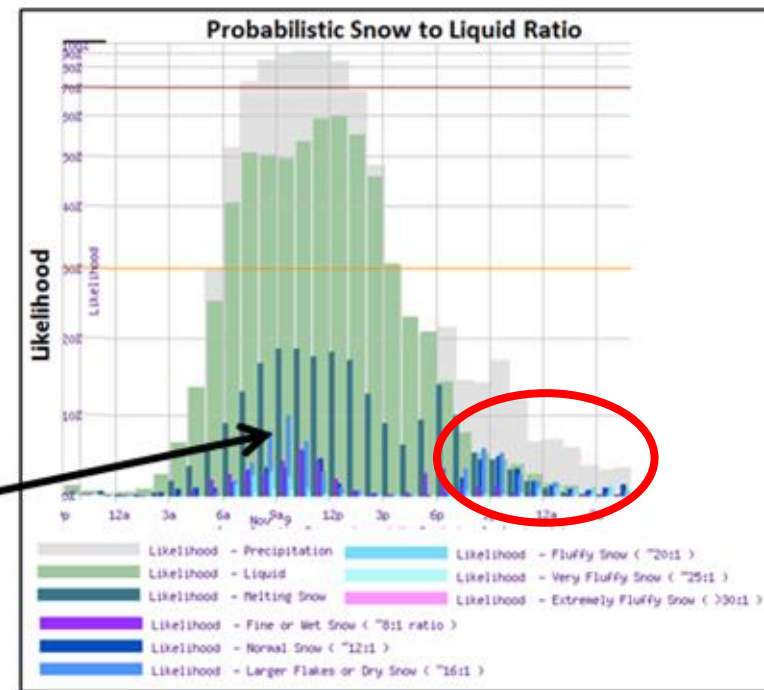


Probabilities for accumulating snow Fri morning are less than 30%. Not expected to increase.

Extremely low probabilities Friday evening are a result of poor resolving of the Lake Michigan lake effect extending into SE Michigan. Expect these probabilities to increase modestly with time.

Moderate to high probability liquid (rain) impacting DTW with some wet snowflakes mixing in Friday morning.

Atmosphere is supportive of all snow precipitation type after 6 PM Friday.

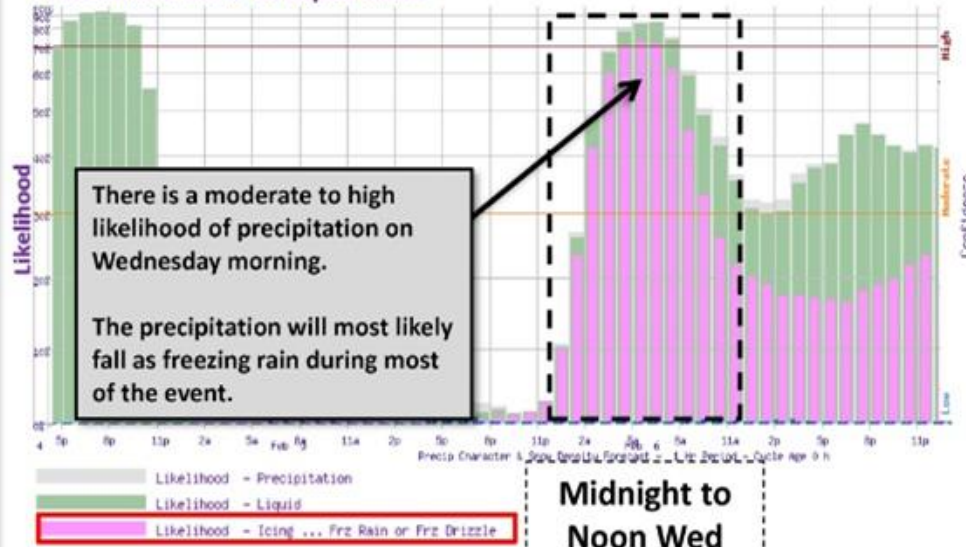


# Example – Feb 4, 2019 Freezing Rain (33 hrs in Advance)

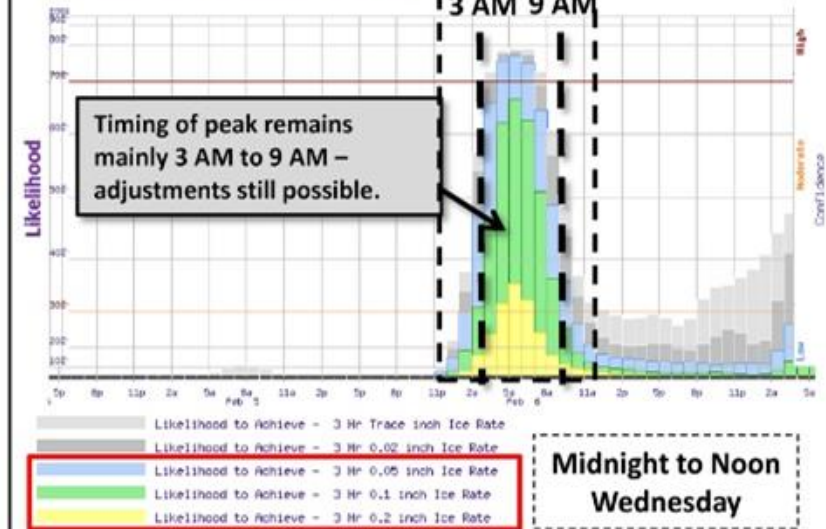
## Updated Outlook - Freezing Rain Potential Wednesday Morning

- Freezing rain appears likely over the region starting early Wednesday morning (roughly 3 AM) and persisting until noon on Wednesday.
- Confidence is increasing in freezing rain occurrence while total icing remains uncertain. The latest data suggests icing on the order of **one to two tenths of an inch** will be possible.
- Temperatures range from the mid 20s (3 AM to 6 AM) and then edge up to around 30 by late Wednesday morning before rising above freezing during afternoon.

### Probabilistic Snow to Liquid Ratio



### Probabilistic 3 hr Guidance for Ice



Temperature projections in the mid to upper 20s are becoming more certain based on the cold front moving through the region tonight.